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Being Human: Life Lessons from the Frontiers of Science

Course Guidebook

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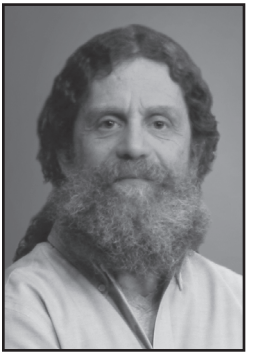

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Professor Robert Sapolsky holds the John A. and Cynthia Fry Gunn Professorship of Biological Sciences at Stanford University, where he is also Professor of Neurology and Neurosurgery. Professor Sapolsky's laboratory focuses on the mechanisms by which stress and stress hormones can damage the brain and on the development of gene-therapy strategies to save neurons from neurological insults. In addition, he has spent most of his summers since the late 1970s studying a population of wild baboons in East Africa, examining what social rank, personality, and patterns of sociality have to do with vulnerability to stress-related diseases.

Professor Sapolsky has been the recipient of many awards for his work, including a 2009 Walter J. Gores Award for Excellence in Teaching, Stanford University's highest teaching honor.

Professor Sapolsky writes regularly for nonscientists in such publications as *Scientific American*, *Discover*, *Natural History*, and *The New Yorker*. He is also the author of 5 books, including 4 nontechnical publications for the general public: *Why Zebras Don't Get Ulcers: A Guide to Stress, Stress-Related Diseases, and Coping* (3rd edition, 2004); *The Trouble with Testosterone and Other Essays on the Biology of the Human Predicament* (1997); *A Primate's Memoir* (2001); and *Monkeyluv and Other Essays on Our Lives as Animals* (2005). ■

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Being Human:
Life Lessons from the Frontiers of Science

Scope:

Why is "maybe" more powerful to your brain than "definitely"? Why do we frequently dream completely nonsensical scenarios? How can biology explain the overwhelming power of symbols and metaphors? This course teaches you entirely new ways to understand the most complex of species: human beings. This unique series of lectures will illustrate many of the ways we are just like other animals, ways we use similar physiology in completely novel ways, and ways in which there is simply no precedent in the animal kingdom for what we do. Furthermore, this wide-ranging course is woven together by remarkable insights provided by evolutionary biology.

From the time scientists started studying cells, it became apparent that the human brain is built from the same general design as every other organ. It consists of cells that contain DNA, proteins, and organelles—cells that communicate with each other via chemical messengers. As we learn more about the evolutionary and physiological roots of humans, we eventually have to ask: Are human beings just another primate? Are we just a bunch of brain cells?

This course teaches you new ways of understanding our humanity and offers a new perspective on the supposedly quirky nature of being human. You'll learn that humans aren't nearly as unique as you perhaps think we are. Study after study demonstrates that the basic aspects of our everyday lives—our social interactions and politics, challenges of adolescence, stress response to our environments, and sexual attraction—are repeated throughout the animal world. By the end of the course, you will have learned entirely new ways of observing and, hopefully, appreciating your own life.

These 12 lectures explore both the mysterious and the mundane aspects of human behavior. You'll look at the human stress response, the allure of junk food, the overwhelming power and science of dopamine, and the

evolutionary basis for nostalgia—and why we should overcome the urge to close our minds to novelty. This course will try to help you make sense of the often-nonsensical nature of your dreams, and you'll learn how the same brain chemical can drive you both to splendid accomplishments as well as to self-destructive behavior. You'll examine the ways that wealth and poverty influence health and gain some surprising insights from neuroscience about the power of human language. You'll even take a look at the bizarre world of mind-controlling parasites.

This course will take you to the frontiers of scientific research—and that's a very exciting place to be because the more science learns about the mechanisms of behavior, the more intriguing our species becomes. Scientists continue to uncover deep similarities between humans and other species, but as research continues to uncover the biological and evolutionary roots of human behavior, it also gives us new reasons to be amazed at the special qualities of being human. Whether it's love, ritual, aspirations, or culture, the unique ways humans make biology work for us makes for endlessly fascinating study.

Even if we are just another primate with brains made up of cells, when it comes to behavior, it is the nature of humans to be remarkably unconstrained by our nature. Much of what you'll learn in this course will be surprising, and some of it will be pretty amusing, but all of it will have you rethinking what it means to be human. ■

What's So Special about Being Human?

Lecture 1

This course explores the following questions: Where do we as human beings place ourselves in the world of social species? How do we make sense of cases in which we are exceptional and those in which we're just like every other animal? Furthermore, how do we make sense of these topics in a scientifically reductive framework? At the end of the day, what makes us function is the outcome of billions of neurons going about their business. With that in mind, how do we think of ourselves as a species?

Social Behavior in Nonhumans

- Gang warfare is a sordid aspect of human behavior, but we also observe organized violence, premeditated protowarfare, in groups of male chimps against members of neighboring groups.

- In another example of humanlike behavior, a troop of baboons with a predominance of females were studied in East Africa over the last decade in which a fluke led to the systematic killing of half of the males—the males who were most aggressive and least socially affiliated.

- In this troop, with a predominance of females, the remaining males had low aggression and high affiliation. As new males came into the troop at adolescence, it would take about 6 months for them to be assimilated into the social milieu of this troop. This process is called cultural transmission.

- In the 1970s, Jane Goodall upended our definition of what makes us human, which was that we are the only species that makes tools. As Goodall discovered, chimps also make tools. Chimps make various types of tools, some of which involve multiple steps, planning, and a fair amount of dexterity.

- The toolmaking skills of chimps are passed on multigenerationally, and a study showed that offspring observe their mothers and learn how to make tools. Furthermore, the sons don't learn nearly as well as the daughters because they don't pay attention—they're busy doing other things.

- There is another domain where, at first glance, we would assume that we're looking at **prosocial humans**, individuals who look out for others and who are willing to do something altruistic, even spontaneously. These individuals have a choice: They have the opportunity to act selfishly or prosocially.

- In a recent study, chimpanzees acted prosocially at a rate that was much higher than expected. Given the option, they would rather choose a scenario in which both they and another individual get a reward. This result becomes more likely when that individual was giving some sort of solicited gesture, but chimps will also do it purely spontaneously.

Surprisingly, chimpanzees engage in protowarfare and prosocial behavior—just as human beings do.

- Another result of this study of chimpanzees that is similar to humans is that when the other individual made a scene and outwardly begged for the food, the chimp was less likely to participate in prosocial sharing. This is an extremely human scenario.

- A human quality that is exemplified in laboratory rodents is the notion that observing someone else experiencing pain lowers your own pain threshold. This can be shown experimentally, and the effect works much better if it's someone you know and like.

- In the case of laboratory rodents, the experiment involves animals observing one another receiving shocks. Hearing the vocalizations that another rodent is giving off lowers that rodent's pain threshold. Amazingly, you get this effect when dealing with cage mates, but not between 2 strangers.

- When we view these types of behaviors in animals and try to interpret them within the supposedly human realms of sociality, emotion, identification, and violence, we must ask: Are we just another animal species?

The Brain

- There's a brain chemical called vasopressin, which is a neurotransmitter. Some parts of the brain use it to communicate with other parts. Vasopressin has some interesting functions in the brain; it is involved with social affiliation and social bond formation, particularly in males.

- Vasopressin comes out of one type of neuron, or brain cell, and has an effect on another neuron. Vasopressin is detected by a vasopressin receptor on the other neuron, which responds to it.

- Vasopressin is coded for by a gene. There's a gene for the vasopressin receptor, and there's a number of different genetic forms of this receptor. A recent study has shown that males have one particular variant of the receptor in which they are more likely

to be in a stable, monogamous relationship and are more likely to derive satisfaction from that fact.

- In different species of rodents, the same variation occurs—one gene that is expressed as male monogamy and another that is expressed as male polygamy. Using gene therapy, you can take the monogamous version of that gene and place it into the brains of the polygamous male rodents, and they suddenly become monogamous.

- In a game called the ultimatum game, economists study cooperation, competition, negotiation, and diplomacy between 2 players. In this game, the first person starts off with $100. That individual makes an executive decision about how to divide the money between himself or herself and the other individual. They can divide it however they choose, for example, splitting it in half or keeping $99 and giving $1 to the other person—they have all the power to decide.

- However, after this step, the second individual has the power to accept or reject the offer. If the second person rejects the offer, neither person receives any money. In other words, the second person has the ability to reject an unfair offer, choosing to receive nothing instead of taking $1, for example.

- Most humans in most cultures that have been studied reject extremely unfair offers. This is economically irrational because it's a lousy deal, but it's better than nothing. Typically, people begin to reject the offer when they are offered $40 or less.

- A whole world of research has been conducted that addresses under what circumstances the refusal rate changes—for example, if you know the person or if you have multiple games against them. Acceptance rates vary as a function of culture.

- In one study of the ultimatum game, researchers took advantage of a new technique called transmagnetic stimulation, in which a powerful magnet is used to stimulate a particular region of a person's cortex. The stimulation silences that particular part of the

brain, which ends up changing people's ultimatum play by making them far more economically rational, far more pragmatic, and far more willing to accept a lousy offer.

- The interesting thing is that if you try this technique with another region of the cortex, you don't get the same effect. Therefore, this effect of changing people's patterns of social play is specific to that particular part of the brain.

- Another brain chemical called oxytocin is like a cognitive vasopressin. Oxytocin mediates social bonding in female rodents and imprints it to their offspring. Oxytocin facilitates the formation of pair bonds that are created with a male for life.

- In the same way that vasopressin has a vasopressin receptor, there is an oxytocin receptor in parts of the rodent female brain. By manipulating oxytocin receptors, researchers can prevent rodent females from bonding to their infants.

- In humans, studies of oxytocin are conducted in which an aerosolized spray that is laden with oxytocin is used by researchers, who spritz the solution up a volunteer's nose (the control group receives a placebo spray). The result is that people become more trusting when they've been spritzed with oxytocin.

- In another experiment, people listen to a supposed political pitch by a supposed candidate, and when they are spritzed with oxytocin, they are more willing to trust the individual—they're more willing to say that the person is making sense and that they would get their vote.

- Remarkably, people become more charitable when they've been spritzed with oxytocin, in the abstract sense of saying they would be more willing to have their taxes used for charitable purposes.

- Oxytocin has given rise to one of the truly alarming ideas of neuromarketing. There is a whole realm of people who are now convinced that if they get you into the right shopping mall and spritz oxytocin all over the place, then you'll buy whatever they are selling.

A Few Questions

- After discovering instances of chimps and other animals engaging in humanlike behaviors, we have to ask the question: Are we just another animal species? Additionally, after learning that we can alter functions of the cortex by spritzing oxytocin, we have to ask a similar question: Are we just a bunch of neurons?

- The common theme is if you want to understand humans as a species, you need to include biology as part of the scenario. As we begin to approach this issue, it is also important to note that you can't understand the brain outside of the context of the body.

- One of the great dichotomies that has existed since the days of French philosopher René Descartes is the notion that the brain handles cognition and emotion very differently—which is completely incorrect. In addition, the classic philosophical dualism of mind and body is incorrect—they are not separate at all.

- While you can't make sense of behavior outside of the context of biology, you also cannot expect biology to explain everything. In addition, you can't solely depend on a certain type of biology.

- Currently, the most exciting realm of biology is the notion that behavior is determined by genetics. This is the heart of Western science's focus on **reductionism**, the notion that to understand a complex system, you need to understand its component parts.

- Reductionism has been great for Western science in many ways; however, it has its limits when it comes to understanding behavior.

- Throughout this course, we will continue to ask ourselves: How do we make sense of ourselves as just another primate species, and how do we make sense of ourselves as an aggregate of neurons? We will keep in mind the theme that biology is relevant every step of the way. At the same time, biology is not going to explain everything about each individual psyche in its social context.

Important Terms

prosocial human: Individuals who look out for others and who are willing to do something altruistic, even spontaneously.

reductionism: The notion that to understand a complex system, you need to understand its component parts.

Suggested Reading

Konner, *The Tangled Wing*.

Questions to Consider

1. What are some striking and unexpected similarities in social behavior between humans and other primates?

2. What are some ways in which human social behavior can be understood down to the level of neurobiology?

Junk-Food Monkeys

Lecture 2

What happens when nonhuman primates get to eat like Westernized humans? A troop of baboons had that opportunity when a tourist lodge—and its garbage pit filled with leftovers—opened in its territory. These baboons abandoned their natural diets, and their bodies responded just like ours would: Insulin levels soared, levels of good cholesterol tanked, and some baboons even developed metabolic syndrome. However, amid these bad developments, these junk-food monkeys also gained some of the benefits of a Westernized diet that we do.

The Nature of Ancestral Humans

- An issue people have been wrestling with for a long time is the nature of our primordial ancestors: How did they look? Were they healthy? What were their diets like? These questions also lead to the question: Are we by nature good, or are we by nature bad?

- One of the first people to study the diet of primordial hominids was a physician and anthropologist named Melvin Konner, who did an ingenious job of trying to reconstruct the Cro-Magnon diet. He discovered that this pre-Neolithic diet included lots of fiber, lots of simple sugars and no complex ones, and very little salt—an ideal diet.

- As an example of modern times, we have studies of traditional hunter-gatherers, who have served as surrogates for our ancestral hunter-gatherers in many ways.

- One of the best-studied populations is the !Kung people of the Kalahari desert in Botswana; they have long been studied to try to understand what the relationship is between the traditional longstanding human lifestyle of hunter-gatherers and what that has to do with health.

- By studying the !Kung people, anthropologists discovered that the traditional hunter-gatherers actually didn't have to work very hard to burn a day's calories; it's a much easier lifestyle than people anticipated.

- What were viewed as some of the inevitabilities of aging—for example, that resting blood pressure tends to increase, that cholesterol levels tend to increase, that there is inevitable cardiovascular degeneration, that healing gets worse as you age—were not found for traditional hunter-gatherers in these Kalahari populations.

- These are virtually inevitable features of Western aging, but not of standard human aging. If you want to be optimally healthy, you want the vaccines of Westernized humans and the diet and lifestyle of hunter-gatherers.

The Transition to Agriculture

- About 10,000 years ago, the transition to agriculture was one of the great leaps forward for human history. This is when we figured out how to establish settlements as a result of farming.

- However, scientists have discovered, by studying the bones of humans from various periods over time, that the onset of farming was a turning point for the worse in terms of human health.

- As you transition from a traditional hunter-gatherer diet to the ones of farmers, you're going from a world in which there are hundreds of different food sources from plants to a relatively small number of them. It has also been shown historically that you're much more vulnerable to famine and draught.

- From the time humans started farming, the average human height started shrinking. As soon as humans became farmers, they became less healthy. You could tell from their bones that there was more evidence of malnutrition and delayed maturation. It wasn't until around 1850 that humans became as tall as Cro-Magnons were.

- Not only was there the feature that these populations were now much more vulnerable to famines and draught, but they also were suffering the consequences of sedentary life. Hunter-gatherers were always on the move in widely dispersed populations, but farming allowed people to invent the permanent settlement, the permanent higher density of humans living together. Then, when someone developed an infection, it was able to move much faster than in the more dispersed hunter-gatherer populations.

- Combining these effects, the onset of agriculture produced a remarkable 30% decrease in life expectancy. It's clear in retrospect that the invention of agriculture, of domestication, is one of the worst human developments.

The Transition to Westernized Diets

- The trend becomes even worse with the transition from traditional agricultural diets to those of Westernized humans. This has been very well studied in 2 different realms: when people have migrated from a more traditional culture to one with a Westernized diet and when the Westernized world has moved in on top of a group of people.

- Studies of some Polynesian populations show that as a Westernized diet sweeps in, populations that used to have essentially a zero incidence of diabetes suddenly has a rate of 70% diabetes. This is a disease of aging, typically in a Westernized way, that involves becoming even more sedentary and putting on weight.

- Diabetes is very prevalent—and increasingly so in the United States, for example—but a 70% rate is not typical of what exists in the general American population. A 70% rate, though, is what you see among these various Polynesian islands.

- There's a great deal of evolutionary logic to the fact that there are such catastrophic responses when Westernized diets are first introduced to a population.

- When you deal with traditional human diets over long periods of time, there aren't many calorie-dense sources of food. There are also intermittent periods of famine, resulting in selection for humans that are really good at storing energy.

- One domain for this is the hormone insulin, which comes out of your pancreas. When you eat something, your blood sugar levels rise and you secrete insulin. Insulin is the hormone of surplus; it triggers energy storage.

- The diet of a traditional primate or hominid requires a body that is really good at storing energy because there is not a lot of energy available and it's intermittent. This type of body has a supersensitive pancreas such that the slightest hint of nutrients in the bloodstream causes insulin to pour out and store the nutrients.

- The kidneys of traditional primates are really good at their job, too. Very little salt is in these diets, so kidneys that are great at retaining salt would end up being called thrifty genes because natural selection has sculpted people to survive and adapt when

Westernized diets, those based on junk food, lead to an increased incidence of various metabolic disorders.

they have these thrifty genotypes. The combination of a Western diet and these thrifty genotypes causes high rates of diabetes and other problems.

- When Westernized diets swept into Europe, for example, a number of centuries ago, the people who didn't have thrifty metabolisms got killed early in life from diabetes. There's an interaction not just between genetics and the selection over the years for a body that is genetically good at storing energy, but you can also see a similar outcome as a function of experience early in life.

- There are 2 main ways in which catastrophe can strike: either natural selection has sculpted you to have very thrifty genes and suddenly you meet a Westernized diet, or a prenatal experience and the imprinting effects of that time set you up to have thrifty genes and then you encounter a Westernized diet.

Baboons and Westernized Diets

- An interesting domain where not only do you see the health effects of a transition to a Westernized diet, but you see a transition to a really lousy Westernized diet is populations of wild baboons living in national parks.

- National parks are very healthy settings. In these ecosystems, baboons only have to spend about a third of their time getting a day's calories. They live in big, safe troops that keep the lions away. Their diet is ideal; it's virtually vegan. In addition, they are walking 5–10 miles a day for foraging.

- A problem that occurs in many national parks is that there's often a challenge of what to do with the garbage being generated in the hotels and tourist lodges in the area because you want to make sure the animals don't have access to it.

- In East Africa, there was one tourist lodge that dumped all their garbage into a garbage pit, which turned into a gold mine for the baboons living around there. These baboons were suddenly

transformed by their diet: They stopped foraging and shifted to living entirely off of the garbage pit.

- Interestingly, when baboons suddenly get this junk-food diet, some of the outcomes are good. For example, these animals hit puberty earlier. Faster development, especially regarding the onset of menses in females, is something that has been seen in humans over the centuries as Westernized diets have become richer.

- In addition, these baboons showed lower infant mortality rates, which was perhaps due to the faster maturation of offspring. There was a shorter interval between giving birth, weaning offspring, and ovulating again. In other words, more offspring were being produced.

- In 1984, there was a tragic drought in East Africa that caused the death of both humans and animals—except for these garbage-dump troops of baboons. Regardless of famine or draught, there were still tourists; thus, there was still food for the tourists, and Westernized tourist food was still being dumped in the garbage pit.

- However, when analyzing the physiology of these animals, things are not so good. The female baboons in these garbage-dump troops were heavier than their counterparts in normal troops. All the baboons, male or female, began to show the first indications of what is called **metabolic syndrome**, which is the first hint of vulnerability for both diabetes and cardiovascular disease.

- With the introduction of the Westernized diet, these garbage-dump baboons started having increased cholesterol levels and, furthermore, increased ratios of bad to good cholesterol. They also began to show insulin resistance, which is one of the first steps of moving toward diabetes.

- In addition, there was an outbreak of bovine tuberculosis in this garbage-dump troop that killed the majority of them. Just like with

humans transitioning to agriculture, the tuberculosis spread quickly in this sedentary, high-density community.

- Was a Westernized diet good or bad for these baboons? Is a Westernized lifestyle good or bad for humans? In both cases, we certainly see some advantages and some disadvantages—some things that have extended our lifestyle and some that have put us more at risk for degenerative diseases. Remarkably, it seems like for baboons as well as for humans, there are very few unambiguous rules of deciding among the choices we have in life.

Important Term

metabolic syndrome: A syndrome that serves as the first hint of vulnerability for both diabetes and cardiovascular disease, among other diseases.

Suggested Reading

Banks, Altmann, Sapolsky, Phillips-Conroy, and Morley, "Serum Leptin Levels."

Eaton, Shostak, and Konner, *The Paleolithic Prescription*.

Questions to Consider

1. What have been some of the health implications of the transition from hunter-gatherer to agricultural diets?

2. What have been some of the implications of the transition to a Westernized diet?

The Burden of Being Burden-Free

Lecture 3

Major psychiatric disorders often result from sufferers being unable to deal with stress. While people with anxiety disorders perceive stressors around them that other people don't, people with depression believe they are helpless under circumstances where they could actually cope effectively. People with both disorders tend to secrete excessive levels of damaging stress hormones. It turns out that there is also an overactive stress response in people with neither of the diseases who are functional and successful but who have repressive personalities, teaching us that it can be enormously stressful to create a world in which nothing stressful ever occurs.

Human Beings and Stress

- In terms of what counts as stressful, in some domains, there's no individual differences. If you are running from a lion, no matter how calm and self-actualized you normally are, you're going to be having a stress response at that time: Your heart is going to be racing; parts of your nervous system will be activated; and you will be secreting stress hormones, such as adrenaline.

- What is being studied is a world in which the stress response is not about running for your life in a short-term physical crisis; instead, it's about what some people perceive to be stressful versus what others perceive not to be stressful.

- The cornerstone of the whole field of stress physiology is built around the notion that this stress response evolved in our bodies for dealing with short-term physical crises, and then we turn them on for chronic psychological stress. Because the system didn't evolve from being chronically activated, there are issues with this system.

- If you are running away from a lion and your blood pressure is increased, that saves your life, but increase your blood pressure

chronically and you're more at risk for cardiovascular disease. You're more at risk for metabolic disorders if you're constantly mobilizing energy; if you're constantly shutting down growth, your immune system eventually will shut down.

- For cognitively socially sophisticated humans, the stress response could also be turning on chronic activation for purely psychological and psychosocial reasons. In this domain, if that continues chronically, you're more at risk for getting sick. This illuminates the relationship between psychological stress and health.

- What makes psychological stress stressful? For the same external reality, you're more likely to feel stressed, to activate a stress response, and to get a stress-related disease if you feel like you have no control over what's going on—if you have no predictability over what's coming, how bad is it going to be, and how long is it going to last.

Air traffic controllers have a very stressful job, and as a result, they either become frazzled burnouts after a few months or do the job happily for decades.

- Furthermore, if you feel like you have no outlets for the frustration caused by external stress—if you feel like you have no social support for it—this is what psychological stress is all about.

- What we see in many research studies is the power of psychological context; loss of control and predictability in one setting can greatly modulate the stress response. In other settings, this loss has no effect at all.

- There are domains in which we love loss of control and loss of predictability; for example, we will pay good money for this loss when riding on a rollercoaster or when listening to a comedian. The difference is when loss of control or predictability is in a setting that we view as benevolent, we like it, and we're willing to relinquish it in order to be surprised.

Individual Differences in Humans

- In the absence of a stressor, the ideal profile for stress response includes low resting heart rate, blood pressure level, and stress hormones. When a psychological stressor enters the scene, it would be ideal for your levels to remain as if there were no stressor.

- When you are presented with a real physical stressor, you should have a massive stress response that increases levels as quickly and as high as possible, and the second it's over, you want to recover as quickly as possible.

- A classic study done decades ago showed how this conditioning emerges over time. Young recruits in the Norwegian military who had just gotten assigned to parachuting school were involved in an intensive stressful training over the course of a few months. Researchers wired them up to be able to look at their heart rate, blood pressure, and hormone levels.

- Researchers measured levels starting with the first jump they ever did and then again months later when they were polished professionals. Before the first jump, these men were experiencing

massive stress responses 6 hours before they even woke up—a feeling that continued throughout the jump and into the evening after the jump.

- After a few months of jumping out of airplanes, researchers discovered that at the moment they jumped, they still had as big a stress response as they did on their first day. However, they had no stress response up until seconds before and seconds after the jump. They were able to get rid of the anticipation and the delayed recovery, only having the stress response when they needed it.

- Classic work focused on another very stressful occupation, air traffic control, and showed a very similar outcome. Apparently, there's a bimodal pattern: People who become air traffic controllers either are frazzled burnouts after 6 months or go decades happily doing it.

- The difference is that the people who were having stress responses hours before and hours after working are not the ones who last. The people who showed up to work in a state of low blood pressure, completed their job in such a state, and returned home are the ones who last forever.

Individual Differences in Animals

- Some work has been done to get insight into individual differences in humans by looking at personality differences in nonhuman primates, such as how reactive a primate is to a novel environment, how befuddled it is by a new setting, and how it deals with ambiguity.

- For example, there are differences in stress-related physiology levels of certain stress hormones in some male baboons as a function of their competitive style. When you look at male baboons who are really good at distinguishing between threatening and nonthreatening scenarios, you see low levels of resting stress hormones. When you look at baboons who can't distinguish between these scenarios, they have highly elevated stress responses.

- In addition, there are tremendous individual differences when you look at whether baboons can seek social support or whether they have a coping outlet.

- In cases where people have bred rats for differences in how they react to novelty, how exploratory they are in a new environment, and how anxious they are, physiological differences are apparent as a function of having bred them for how they react to psychological stressors in their environment.

Psychiatric Disorders and Stress

- How much of individual difference is genes, and how much is environment? This is an area of ongoing research. This notion also applies to humans to make sense of some of the most common psychiatric disorders. The way to think about many of these disorders is that there's a mismatch between the external reality and the stress physiology that people have in response to it.

- For example, **anxiety** is basically seeing stressors, menace, and threats that other people don't. It means you're turning on the stress response at times when other people are not perceiving anything.

- On average, people with general anxiety disorders have more activation of a part of the body called the sympathetic nervous system, which is the source of adrenaline. The more activity there is in the adrenaline part of your nervous system, the more another class of stress hormones is secreted, leading to an increased risk of cardiovascular disease. In other words, there is a chronic activation of the stress response in these types of people.

- Instead of a personality style built around hostility, the much more modern incarnation of a type A personality is called **toxic hostility**: Everything that occurs in the world around you is proof that everyone is out to get you, and the only defense you have is to watch your back at all times. You are not only seeing threats that other people don't, you're also seeing a very specialized attribution response.

- The profile of someone who exhibits toxic hostility includes increased risk of cardiovascular disease and overactivation of the sympathetic nervous system, which controls adrenaline.

- Experimentally, to show someone's toxic hostilities—tendencies to be extreme—researchers will have the person complete a team task and have their partner intentionally make mistakes continuously. Type A individuals cannot handle these scenarios; they just about have a heart attack.

- Another example of this is seen with clinical depression, another realm in which there is a mismatch between external reality and the stress response. With depression, instead of seeing stressors that other people don't, you're seeing hopelessness and helplessness that other people don't.

- Major depression is characterized very frequently by elevated levels of stress hormones and by a nontrivial increase in risk of cardiovascular disease, another realm where there are pathological implications of individual differences.

- One of the most interesting examples of individual differences has to do with a personality profile that involves a repressive style of dealing with emotions. Individuals with a repressive personality style are not anxious or depressed; instead, they very tightly regulate their emotions. These are people who don't express many emotions, and they're not good at reading them in other individuals.

- This is not a psychiatric disorder. In fact, people with a repressive personality style tend to be highly functional, highly successful, and very disciplined. They often rate themselves as being happy, and research shows that they actually are. This is a personality profile of about 5% of people.

- Research has shown that in people with these repressive personality styles, their frontal cortex, which regulates emotion, is extremely active. In addition, they have elevated levels of stress hormones.

This shows that people with this personality profile expend enormous amounts of energy building a wall between them and the vibrant, unpredictable world.

- In many ways, individual differences in the stress response and what it looks like in individuals with these repressive profiles teaches you something very surprising and important: Sometimes it can be incredibly stressful to create a world for yourself in which something stressful never occurs.

Important Terms

anxiety: The state of seeing stressors, menace, and threats that other people don't; in other words, turning on the stress response at times when other people are not perceiving anything.

toxic hostility: A modern incarnation of a type A personality in which people believe that everything that occurs in the world is proof that everyone is out to get them, and the only defense they have is to watch their backs at all times. The profile of someone who exhibits toxic hostility includes increased risk of cardiovascular disease and overactivation of the sympathetic nervous system, which controls adrenaline.

Suggested Reading

Sapolsky, *Why Zebras Don't Get Ulcers*.

Tomarken and Davidson, "Frontal Brain Activation in Repressors and Nonrepressors."

Questions to Consider

1. Why are Westernized humans so prone toward stress-related diseases?

2. What is a repressive personality profile, and what is the physiology that accompanies it?

Bugs in the Brain

Lecture 4

Organisms that parasitize the other organisms they infect for their own benefit—stealing the host's energy and commandeering its replication machinery to make more copies of itself—are parasites. There's a whole world of bizarre cases of parasites that exploit their host by altering its behavior. A truly astonishing case involves a protozoan parasite called toxoplasma, which infects mammals and changes the wiring of their brains to make them do some of the strangest possible things. Toxoplasma also seems to have strange effects on humans.

Parasites as Invaders

- **Parasites** target and invade organisms for their own benefit. For example, a parasite can steal energy from the host organism. It can use the energy to reproduce and make more copies of itself, or it can hijack the reproductive machinery of the host species to make more copies of itself.

- Parasites can manipulate the behavior of the organisms they infect, and they come in many different forms. There are some wild examples of ways in which parasites, independent of altering behavior, do things for their own benefit.

- A virus called herpes simplex virus (HSV) is able to measure levels of stress hormones in your blood system, so it knows when you are stressed and can arise—after initial infection—suddenly after being latent for a period of time because stress suppresses your immune system.

- Another example is trypanosome, which is a parasite that invades your immune system in an amazingly clever way. Normally, your immune system scans for foreign pathogens by identifying alien proteins on the surface of parasites and then producing antibodies. However, trypanosome occasionally withdraws its surface proteins

and puts up completely novel surface proteins so that just when your immune system is ready to go after it, it's immunologically invisible.

- Another parasite called schistosome steals some of the surface proteins from your own cells so that your immune system doesn't even notice it doesn't belong there.

Parasites and Behavior

- Parasites can manipulate the behavior of the host for their own benefit. For example, **ectoparasites** are parasites that don't actually get inside the body of an organism but remain outside. Mites are ectoparasites for ants; they ride on the backs of ants and cause them to disgorge whatever food they are carrying back to the nest. The mites then consume the food instead.

- A pinworm lays its eggs on the fur of a rodent, which has the chemical means to make the rodent unbelievably itchy. The rodent needs to scratch itself, so it gnaws at the area and, in the process, ingests some of those eggs. Inside the gut of a rodent is the ideal place for the eggs to reproduce.

- **Endoparasites** get inside the body and alter the behavior of the host. Some of the most interesting examples of this involve sequential parasites, which have to infect one type of species, transfer to another one and reproduce, and eventually get back to the original one. Their life cycle is a multispecies cycle.

- There is a parasite that moves between a species of fish and a species of waterbird. When it's in the fish, it disturbs the functioning of the gills so that the fish has to swim closer to the surface to get more oxygen and is, therefore, more readily eaten by the waterbird, which eventually excretes the parasite. The parasite then falls back into the water and is eaten by another fish, and the cycle continues.

- One type of barnacle parasitizes a sand crab by injecting estrogenic (female) hormones. When injected into a male crab, the male starts having female-typical crab behavior, including digging a nest in the sand to lay its eggs. Because the male crab is not going to be laying any eggs, the barnacle can do so at that point. When the barnacle interacts with female crabs, it does the same thing, but first it castrates the female, destroying her ovaries, which is called parasitic castration.

- When a Brazilian moth is in the caterpillar stage, it can be parasitized by a type of wasp that stings it and lays eggs inside the caterpillar. After a certain amount of time, the eggs inside the caterpillar hatch and use the innards of the caterpillar for nutrients. Eventually, these eggs and the pupae they've made burst out of the caterpillar, but some of them stay inside and affect the nervous system of the caterpillar so that it defends the new hatchling wasps.

- There is a fungus that infects a certain species of rainforest ant, causing it to develop a **phototropism**, which means it is suddenly attracted to light. These ants normally live on the floor of the forest, but once they are infected by this fungus, they climb up trees. When they get to a particular height, the parasite takes over and causes the ant to eat a leaf up there, where it stays and dies. At that point, the fungus emerges and grows on the ant.

- A cockroach is parasitized by a wasp known as the emerald cockroach wasp, which stings the host and delivers venom that changes the cockroach's neurochemistry and inhibits its escape reflex. Then, the wasp grabs the antenna of the cockroach and leads it to its own nest, at which point the wasp lays an egg on the cockroach's abdomen that later hatches. The hatched wasp feeds on the cockroach and ends up inside its body before emerging to begin its adult life.

Parasites and Mammalian Hosts

- The really interesting domain of parasites manipulating host behavior comes about when we start looking at parasites that can alter the behavior of mammals for the benefit of the parasite itself.

- An important distinction is that parasites can induce sickness behavior, in which the behavior of the host organism changes—not because the parasite is manipulating behavior for the benefit of the parasite itself. The rabies virus, like all viruses, is some form of parasite. This virus finds a way to make as many copies of itself and passes them on. Rabies is transmitted by making the host organism rabid—more aggressive and more likely to bite another individual. Copies of the virus are lurking in the saliva of the rabid animal and frothily get transferred to the next organism, altering its behavior.

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A type of mite rides on the back of an ant and makes it disgorge its food, which is then eaten by the mite.

- There's one vulnerability on the part of the rabies virus: the nonspecific nature of what happens after it makes a host rabid, which may result in the host biting another organism that doesn't offer rabies the means to manipulate behavior and get passed on.

- A protozoan parasite called toxoplasma has a way to avoid accidently stumbling into dead-end species. Toxoplasma is a sequential parasite that is found in cat feces. It can only reproduce sexually in the guts of cats and is excreted in cat feces, which are frequently eaten by rodents. The revolutionary challenge for toxoplasma has been to find a way to get the infected rodent inside the stomach of a cat to complete its life cycle.

- Rodents have an instinctual aversion to the odors of cats. However, toxoplasma eliminates that aversion. In fact, rodents that are infected with toxoplasma develop an attraction to it. Because of this attraction, toxoplasma makes it more likely that the rodent will end up in the stomach of the cat, completing its life cycle.

- A logical explanation is that the rodents' behavior is affected because there is a parasite in their brains and they're not acting normally. However, toxoplasma-infected rodents show perfectly normal learning and social behavior.

- Toxoplasma is not simply eliminating the pathways for fear in the brains of these rodents—it is doing it selectively. Amazingly, closely related protozoa parasites are not able to induce this fatal attraction in rodents. In addition, they don't have the limitation of only reproducing in cats. Furthermore, toxoplasma does not change how infected rats feel about the smell of other predators.

- Toxoplasma gets into the gut of rodents because the rodents will ingest infected feces from cats. Slowly, it migrates from the gut into muscle, for example. It also migrates into the brain and into the nervous system of these rodents, where it changes behavior. Somehow, toxoplasma preferentially migrates to the brain region that is most famously involved in fear aversion, the amygdala. Once in the amygdala, toxoplasma is able to cause neurons there to atrophy, disconnecting specific fear circuits.

- Remarkably, toxoplasma is able to do some rewiring in the brain, hijacking a circuit that normally responds to sexually arousing odors in these rodents to produce an attraction instead. As a result, the rodent decides that cat urine smells unbearably good and, thus, somehow ends up inside the stomach of the cat.

- Toxoplasma infection in humans is associated with an increased risk of schizophrenia due to changes in neurochemistry. Schizophrenics have a higher-than-expected rate of having had toxoplasma exposure early in their lives. It is well known if you are pregnant

to avoid cat feces because you may get infected with toxoplasma, which can get into the fetal nervous system.

- Toxoplasma also has more subtle effects on behavior. Men who are infected with toxoplasma become disinhibited with their behavior. Some studies have shown that toxoplasma also affects coordination and can increase the likelihood of impulsively committing suicide.

- There have to be more examples of parasites manipulating our behavior that are unknown at this point. This toxoplasma example teaches us to have evolutionary humility: We humans have opposable thumbs and large brains, but we are not necessarily the most evolved or the most clever species.

Important Terms

ectoparasite: A type of parasite that remains outside the body of an organism and alters the behavior of its host.

endoparasite: A type of parasite that gets inside the body of an organism and alters the behavior of its host.

parasite: An organism that targets and invades other organisms for its own benefit.

phototropism: Having an attraction to light.

Suggested Reading

Moore, *Parasites and the Behavior of Animals*.

Torrey and Yolken, "*Toxoplasma gondii* and Schizophrenia."

Vyas and Sapolsky, "Manipulation of Host Behavior by *Toxoplasma gondii*."

Questions to Consider

1. What are some of the unlikely ways in which parasites manipulate the behavior of different types of invertebrates?

2. What does toxoplasma do to a host's behavior?

Poverty's Remains

Lecture 5

Even after death, there's a socioeconomic gradient in medicine. For centuries, physicians have learned anatomy by dissecting the cadavers of the poor. From medical students moonlighting as grave robbers to laws requiring that executed criminals be publicly dissected, this makes for some wild history. This lecture focuses on the time that a doctor failed to appreciate that poverty changes the body and, as a result of this mistake, invented an imaginary disease—and the medical procedure meant to prevent this imaginary disease killed thousands of people.

The Poor and Autopsies

- We have very ambiguous feelings about dealing with mortality, especially with the fact that our own mortality is inevitable. As a manifestation of that, human bodies—and what can be done with them after death—unnerve us.

- One result of this feeling is that the incidence of autopsying has decreased drastically. People are much less likely to allow a loved one, or even themselves, to be autopsied. This has some medical consequences because autopsies can be very useful.

- For one thing, autopsies can sometimes tell the cause of death, and sometimes they can confirm or contradict a diagnosis that the doctors gave. Sometimes they can be used for research or teaching. In order to get trained as a physician, you need to learn anatomy from a corpse.

- Throughout the history of medical education and research, it's not random whose bodies were autopsied; over the centuries, it has proportionally been the bodies of poor people. This trend ended up generating a disease that accidentally got invented around 1900. People didn't know that something was different about the bodies of the poor versus others, and this odd quirk of mistaken pathology was the cause of at least 10,000 deaths.

- In the 16th century, King Henry VIII made a law during his reign that criminals who were executed would then be dissected by anatomists. What was clear about that period was people who were getting executed were disproportionally the poor. This was a time when stealing a loaf of bread could cause you to be sent to the gallows.

- By the 18th century, this trend had been growing because there were more medical schools, which were beginning to resemble our modern notion of medical school. Out of that came a new occupation: You could be what was called a **resurrectionist**, obtaining bodies of the dead and selling them to anatomists at medical schools to learn about the human body.

- Not only were these resurrectionists often out at night digging up corpses from the graveyards, but they were sometimes raiding funerals and stealing bodies. Body stealing was far more likely to have occurred with the bodies of the poor than the wealthy because the wealthy during that period would often pay for an armed guard at the funeral to keep the resurrectionists out.

- In addition, poor people were often not buried in coffins, or if they were, the coffins were made of flimsy material and were buried in fairly shallow ground. In contrast, the wealthy were buried in impregnable coffins that were placed very deep in the ground.

- The poor began to notice that they were being disproportionately autopsied, and as a result, many resurrectionists, anatomists, doctors, and medical students were lynched by angry crowds. These crowds burned down hospitals where the bodies of the poor were being dissected, and they even burned down the homes of the anatomists.

- Around 1780, an event occurred at what is now Columbia University in which medical students decided to cut the resurrectionists out of the business and were caught digging up bodies of the poor. This generated a riotous displeasure on the part of the poor.

- By the 19th century, all of this turmoil gave rise to laws in a number of European countries that were typically known as anatomy acts, which said that if a person had died and the relatives could not pay for the medical expenses, the body was to be automatically sent to the anatomists. By the mid-19th century, best estimates are that 99% of the bodies that were autopsied were bodies of the poor.

- A version of this still goes on today; there is still a disproportionate bias, but it's not quite as dramatic. In India, for example, people still buy the bodies of the deceased from poor people to be shipped elsewhere and turned into a skeleton for educational purposes. In some cases, the relatives even try to hasten the demise of their relatives in order to receive this extra cash.

The Poor and Stress

- As a function of their socioeconomic status, people have different diseases; the poor aren't as healthy as the wealthy. The fact that the poor were being preferentially autopsied gave rise to a very surprising outcome that has to do with an interesting thing that happens during stress.

- During stress, you secrete all kinds of stress hormones, and one of the things that chronic stress does is it causes atrophy of some parts of the body and hypertrophy of other parts. There's a particular organ that gets smaller, and that's the cause of the medical disaster of 1900.

- By the early 20th century, physicians were wrestling with the cause of the disease that is commonplace now—a disease that then was known as crib death. Today, it is called **sudden infant death syndrome (SIDS)**. In the early 20th century, it was just being recognized as a disorder in which a perfectly healthy child, typically a baby, is put to sleep at night and mysteriously dies.

- Chronic secretion of adrenal stress hormones make your adrenals larger. Meanwhile, in your throat, there is a gland called the thymus

gland, which deals with immune defenses. What was found very soon after the discovery of these stress hormones is that they cause atrophy of the thymus gland—they cause it to shrink.

- The fact that people didn't understand the role of stress combined with the fact that they were learning their anatomy disproportionately from the bodies of the poor resulted in this SIDS catastrophe.

- Today, we're getting some insight into what SIDS was about, but in 1900, the way to understand this newly recognized disease was anatomy. During that time, a German anatomist did one of the first studies to try to understand what was different about the bodies of children who died from SIDS. Note again the requirement for SIDS was that the child wasn't sick, so infants who died from SIDS tended to be middle or upper class.

- Because of the fact that anatomists at that time were disproportionately studying the bodies of the poor, they were learning a totally incorrect idea as to how big the thymus gland is supposed to be in a human baby body. They thought they were looking at normal-sized thymus glands, but in reality they were looking at thymus glands that had shrunk as a result of the stressors of being poor children dying of chronic diseases.

A Disastrous Medical Mistake

- A. Paltauf was one of the first to autopsy the bodies of middle-class SIDS children, whose bodies were not warped by poverty and whose thymus glands had not shrunk. Comparing these bodies to the anatomy of the body of an infant with a "normal" thymus gland, he immediately realized that the thymuses in these SIDS children were abnormally enlarged—a syndrome called status thymicolymphaticus.

- Out of this discovery came a perfectly plausible theory: For whatever mysterious developmental reason, some children have an enlarged thymus gland, and at some point during sleep, it presses

down on the trachea and suffocates the child at night. Today, we know this was completely wrong.

- By the early 20th century, this very influential theory was catching on. By the 1920s, this disease was in every pediatric textbook, and people even knew how to prevent SIDS—through a wonderful new technology that involved irradiating the throats of babies to shrink the abnormally enlarged thymuses.

- Today, we know this is all nonsense, but this new technology led to a really bad outcome because right next to the thymus is the thyroid gland, which can develop thyroid cancer if subjected to too much radiation. Best estimates are that this intervention of shrinking abnormally large thymus glands were the cause of death of at least 10,000 people.

- It wasn't until the 1930s that people began to understand the effects of stress on the thymus gland. A man named W. Nelson, a young intern at the time at the University of Pennsylvania, was the first

One result of the fact that people are disturbed by dead bodies is that the incidence of autopsying has substantially decreased over time.

one to realize that these children did not have abnormally large thymuses; instead, they had normal-sized thymuses. He was also the first person to warn people against radiating the thymuses of these children. Nevertheless, people continued to do so for a remarkably long time afterward.

- Unfortunately, there is a focus on the simple fact that socioeconomic status affects health. If people can't live equally in their health as a function of their socioeconomic status, at least they should be autopsied at equal rates because this bias has caused all sorts of problems.

- Another lesson to be learned is that sometimes people need to resort to doing simplistic biomedical research because sometimes it's not easy to be sure what is a normal-sized gland, for example, without disastrous consequences.

- The biggest lesson that comes out of all of this is one that transcends medicine, biomedical research, and science—one that is relevant to virtually every aspect of how we make decisions: Be very careful when deciding what counts as a normal state because once you've decided what normal is—convinced yourself of it and pronounced it—you have forever distorted your ability to look at an exception to that supposed normality and see it for what it really is.

Important Terms

resurrectionist: In the 18th century, a person who would obtain bodies of the dead and sell them to anatomists at medical schools to learn about the human body.

sudden infant death syndrome (SIDS): Known as crib death in the early 20th century, this is a disorder in which a perfectly healthy child, typically a baby, is put to sleep at night and mysteriously dies.

Suggested Reading

Lucas, *Modern Practice of Pediatrics*.

Richardson, *Death, Dissection, and the Destitute*.

Questions to Consider

1. Why is there a link between socioeconomic status and anatomy?

2. Why was status thymicolymphaticus invented?

Why Are Dreams Dreamlike?

Lecture 6

Despite the fact that we sleep for about a third of our lives, it's still not clear how sleep works. The most puzzling aspect of sleep is dreaming: Why does the brain generate sensory imagery while you sleep, and why is the imagery so strange? With the onset of sleep, spontaneous activity in most of the brain decreases, but with the onset of rapid eye movement sleep, the stage in which dreaming occurs, a truly fascinating region of the brain goes completely offline. As a result, the rest of the brain runs wild.

Why Do We Sleep and Dream?

- When dreaming, you are often engaged in some activity that is unlikely because you either couldn't or wouldn't do it in everyday life. Some of the time, dreaming serves to give concrete information or to foster creative problem solving. There's also the view that dreams warm up underused circuitry in your brain that doesn't get enough activity during the day.

- In order to get a sense of why we have dreams, we have to begin with why we sleep. Sleep is an ancient phylogenetic phenomenon; in other words, many unlikely species, such as fruit flies and worms, engage in sleep.

- Carnivores sleep much more than prey species because prey spend the majority of the time being unrestful, keeping an eye out for the carnivores, who can sleep for 20 hours without needing more food after a large meal.

- There are some oddities in the sleep world: There are fish that can sleep with half of a brain at a time and migrating birds that are able to sleep while flying.

- Sleep is a widespread phenomenon, and it is not just an unmodified, undifferentiated state of sleeping; instead, there's a whole structure to sleep. There's **slow-wave sleep**, the deepest stage of sleep, and **rapid eye movement sleep (REM)**, the stage associated with dreaming.

- Interestingly, there's a number of different psychiatric disorders in which the structure of sleep has been changed. For example, in major clinical depression, the normal pattern of having approximately 90-minute cycles of different sleep stages is altered. This is one of the most striking ways of exhibiting depression, which is a biochemical disorder.

- People studying sleep use electroencephalography (EEG), which shows the degree of alertness of different brain regions, to look at the electrical activity of large parts of the brain all at once. There is a structured pattern of what the EEG does at during various stages of sleep.

- The EEG technique shows that when you go into slow-wave sleep, overall electrical activity decreases in the brain. Sleep, particularly during the slow-wave sleep state, is a time when your brain restores energy. Sleep deprivation induces what is called a sleep debt, after which you sleep more. A greater percentage of the sleep period afterward is spent in this restorative slow-wave sleep stage.

Stress and Sleep

- Stress has adverse effects on sleep. Stress makes it more difficult to fall asleep. In addition, lack of sleep is stressful. There is a vicious cycle in which stress impairs sleep, which causes more stress, which leads to more sleep impairment.

- Stress also has an effect on some of the energy stores in the brain. A compound called glycogen is a storage form of energy in the brain, and stress decreases the extent to which glycogen is built up again during sleep. Stress not only makes it harder to fall asleep, but once

you are asleep, it reduces the quality, efficiency, and restorative energetic effects of sleep.

- In addition to having less sleep, having fragmented sleep—and especially sleep fragmented at unpredictable times—wreaks havoc on the ability of your brain to restore energy stores during slow-wave sleep.

- In recent years, EEG approaches have been coupled with modern brain imaging techniques—such as PET scans and MRIs—to be able to look at particular subregions of the brain instead of the brain as a whole. Researchers have used EEGs to determine what sleep stage someone is in, but then they use brain imaging techniques to determine which parts of the brain become more or less active during sleep.

What Happens during Sleep?

- Allen Braun and his colleagues at the National Institute of Health had volunteers go 24–53 hours without sleep. Eventually, researchers did MRI scans on these people to get baseline measures and to find out what their brains were doing at the point of sleep deprivation. Finally, they allowed the volunteers to fall asleep inside the MRI scanners so that they could see what changes occur in particular brain regions as someone transitions from being awake to going into sleep states.

- Overall, researchers found that there's a decrease in activity in most of the brain regions with the onset of slow-wave sleep. For example, there's a system in the brain called the reticular activating system, which is involved with alertness and arousal. Logically, the level of activity of this system decreases drastically with the onset of slow-wave sleep.

- In addition, the activity of many parts of the brain that have motoric functions, which give commands to the muscles, becomes quiescent. Some parts of the brain that are centrally involved in memory become very quiet as well.

- After about 90 minutes, the person on the scanner hits his or her first stage of REM sleep, the dreaming stage, and some regions suddenly become active—even more active than when the person is awake.

- The first parts to become active are the parts of the brain that are involved in autonomic function, which is brain function that you do not regulate consciously, such as heart rate and breathing rate. With the onset of REM sleep, your heart rate increases your breathing rate while turning on aspects of your autonomic nervous system.

Using electroencephalography, people can study sleep by looking at the electrical activity of large parts of the brain all at once.

- Another region of the brain that gets activated with the onset of the REM stage—perhaps even more than when awake—is a part of the brain called the limbic system, a loose association of a bunch of brain structures that are related to emotion. The limbic system becomes highly active because dreams are marinated in the functioning of the limbic system.

- Another cluster of brain structures that become more active is a region called the hippocampus, which deals with parts of the cortex that are involved in memory formation and memory retrieval. This is the ability of dreams to be dredged-up memories, reviewing some of the information or memories that came through during the day and then influencing dreams.

- Another interesting area of the brain that becomes highly active when you are in REM sleep is an area of the cortex called the associative sensory cortex. One domain of the associative sensory cortex is the associative visual cortex, which generates complex visual stimuli.

- During REM sleep, the more complex associative visual cortex suddenly becomes very active; strangely, however, the primary visual cortex is absolutely silent. This is because you are dreaming visual imagery that's not actually coming into your head because you're asleep. Instead, your mind is generating dream material on its own.

- Interestingly, the activity of the prefrontal cortex decreases dramatically with the onset of REM sleep. The prefrontal cortex is arguably the most interesting part of the brain. It's the part of the brain that most completely defines who we are as humans; as a percentage of total brain weight, we have more of it than virtually any other species.

- The frontal cortex regulates behavior; it resists the easy solution. It puts restraints on behavior through gratification postponement, long-term planning, and self-discipline.

- Interestingly, if you have damage to the frontal cortex, many aspects of your behavior are impaired, including your ability to appropriately regulate behavior. People with this type of damage to their brain know the difference between right and wrong, but nevertheless cannot regulate their behavior.

- Another interesting feature of the frontal cortex is that it's the last part of the brain to fully develop. Amazingly, the frontal cortex is not fully matured until you're about 25 years old.

- The frontal cortex has lower-than-normal levels of activity in people with sociopathic personalities; people with repressive personalities have overactive frontal cortices. Damage to the

frontal cortex results in people doing all sorts of disinhibited and inappropriate things.

- During normal days, the frontal cortex is reigning in the limbic system's emotionality. During dreams, the frontal cortex's metabolic rate decreases drastically, and the limbic system goes out of control at that point because the part of the brain that imposes linear, rational regulation of your emotional brain goes offline when you enter the REM stage.

Remaining Questions about Sleep

- Dreams are dreamlike because your prefrontal cortex metabolically decreases during REM sleep. The result is that the limbic system is disinhibited and runs wild, and you have dreamlike content in your dreams. People are still trying to understand why this happens during REM sleep.

- We still don't know if there is a relationship, for example, between how much of the frontal cortex silences during REM sleep and how vivid dreams are. In addition, we still don't know if there is an inverse relationship between how active your frontal cortex is during the day in terms of metabolic rate and how much it then goes offline during REM sleep.

- Interestingly, people with repressive personalities, those who are highly emotionally regimented, have normal levels of frontal cortical function that are higher than most other people's. Perhaps this is because their frontal cortices work so hard during the day that they go completely offline during dream stages, resulting in dreams that are incredibly vivid.

- A few unanswered questions remain in sleep science: Why does the frontal cortex go offline with the onset of REM sleep, and where do individual differences come from in regards to the explanation for the content of dreams? More research is needed on both accounts.

Important Terms

rapid eye movement sleep (REM): The stage of sleep associated with dreaming.

slow-wave sleep: The deepest stage of sleep.

Suggested Reading

Braun, et al., "Dissociated Patterns of Activity in Visual Cortices."

Hobson, *Dreaming*.

Questions to Consider

1. What are the functions of the frontal cortex?

2. What are the differences in patterns of brain activation when comparing people who are awake, in slow-wave sleep, and in REM sleep?

The Pleasures and Pains of "Maybe"

Lecture 7

Humans are capable of astonishing displays of gratification postponement. This capacity for gratification postponement has a lot to do with a neurotransmitter called dopamine. Scientists originally thought dopamine was about pleasure and reward, but it is actually more about the anticipation of reward than about reward itself. Even more so, it's about the work needed to achieve that reward; dopamine is the pursuit of pleasure, not pleasure itself. Nothing gets dopamine going like "maybe," the possibility rather than the certainty of reward. The neurobiology of "maybe" helps explain instances of magnificent motivation and of crippling addiction.

The Frontal Cortex and Dopamine

- Why are we primates, including nonhuman primates, willing to deal with long delays in gratification? Why do we keep persisting without any reinforcement—failure after failure?

- The limbic system holds the power of intermittent reinforcement. To understand this power, we must focus again on the frontal cortex, the most decidedly human part of the brain.

- An interesting implication is if the frontal cortex is the last part of the brain to develop, it's the part of the brain that is least constrained by genes and most shaped by experience.

- The frontal cortex makes you do the harder thing when it's the right thing to do. It sends inhibitory projections down to the emotive, disinhibited limbic system, telling you not to do something. The frontal cortex is particularly good at showing some capacity for gratification postponement.

- Science is beginning to understand this process because of an interesting neurotransmitter chemical in the brain called dopamine

that sends information from one neuron to the next. Dopamine is involved with pleasure and reward.

- There's a whole paradigm in neuroscience called self-stimulation in which researchers find the dopaminergic part of a rat's brain and put an electrode in it. The rat presses a lever, and as a result, it gets stimulated in the dopaminergic region. The rat works like mad as a result of being stimulated in these dopaminergic pathways, which are where the dopaminergic neurons that are about pleasure and reward are located.

- The dopaminergic part of the brain suddenly becomes activated when an unexpected reward is presented, and it becomes instructive in trying to figure out what caused the receiving of the reward. Then, there becomes a need to understand cause and effect. At that point, the frontal cortex and the dopamine system have a lot to do with the feedback that occurs.

- What then goes into these calculations in the brain are things like time discounting: How long do you have to wait to get the reward? We value a reward less if we have to wait a longer time for the reward to come.

- Dopamine plays a big role, helping you discern between 2 different options to determine which is more valuable—which you should devote more of your efforts to obtaining.

- **Parkinson's disease** is a neurological disorder that causes a person to lose all of the dopamine-releasing neurons in the part of the brain having to do with smooth movement, which is completely unrelated to the part of the brain we have been discussing.

- Individuals with Parkinson's disease also lose some dopamine neurons in the reward pathway, and as a result, they are not very good at shifting their game strategies when the size of the reward shifts. Most people can modify their behavior to maximize the reward based on an updated value.

- Levodopa, or L-dopa, is a drug that is often given to people with Parkinson's disease to boost dopamine levels. This causes the accuracy at choosing the optimal strategy to return.

Dopamine and Behavior

- One of the true tragedies of human nature is illuminated when you consider the tough task that the dopaminergic system has to take on. This is a world in which our pleasures are incredibly heterogeneous—one in which pleasure can come in various forms. How can this dopaminergic system deal with such a wide range of rewards, from hitting the lottery to noticing that spring is coming?

- The secret to how this system codes all of this is that it habituates to any given reward very quickly; in other words, it's ready to respond to a new reward as soon as it's finished with any given reward.

The neurobiology of gambling involves being willing to put enormous amounts of goal-directed behavior into the possibility of an intermittent reward.

- Because of this, you see some miserably depressing effects that impact our lives. If you quickly habituate to what counts as the norm, a reward that is doubled and given to you is excellent at first but then quickly becomes mundane. Furthermore, it becomes what is expected if you are to remain satisfied. However, research shows that this thinking is simplistic and incorrect.

- Many subtle insights come from the work of a scientist named Wolfram Schultz and his colleagues at the University of Cambridge in England. He has shown in his research with monkeys—with which they used imaging to see when dopamine pathways became excited—that, in fact, dopamine is not really about reward.

- Schultz and his colleagues trained monkeys to press a lever in order to get a food reward, but they also trained the monkeys to recognize when they were starting one of those reward sessions by turning on a light. The light was then the indicator that if the monkeys pressed the lever, they would receive a reward.

- What was previously thought is that the monkey does the work, receives the food, and the dopamine increases. However, Schultz showed that once the monkey understands the process, dopamine does not increase when the reward occurs; instead, dopamine increases when the light turns on. This showed that dopamine actually increases in anticipation of the reward.

- Dopamine turns out to be more even than that. It's not just about the anticipation of the reward; it's about the goal-directed behavior. It's about what you are willing to do, the effort you're willing to expend, to get that reward. The frontal cortex gets the energy to obtain the reward from dopamine.

- Dopamine is not about happiness; it's about the pursuit of happiness. However, this relationship between dopamine forming the motivation for goal-directed behavior and receiving the reward is not as straightforward as it seems.

Dopamine and Intermittency

- Some of the more subtle work done by Schultz tells us about the neurochemistry of not just reward, but of intermittent reward. In his work with monkeys, the light comes on, signaling the start of one of these reward sessions. The monkey does the work and gets the reward with a 100% relationship guarantee.

- When the researchers shifted it to a 50% relationship—in which only half of the time the monkey received the reward—when the light comes on, dopamine increases drastically. Therefore, intermittency intensely fuels dopamine. We have just introduced the word "maybe," which is incredibly motivating.

- Then, the researchers shifted the reward rate so that either 25% or 75% of the time the monkey would do the work and get the reward. These rates are diametrically opposite from 50%, but they both have a greater degree of predictability than 50%. In both of these scenarios, there is still a burst of dopamine, but it's not quite as big as 50% while still bigger than 100%.

- This is the neurobiology of gambling—of willing to put enormous amounts of goal-directed behavior into the possibility of an intermittent reward; nothing boosts up dopamine like an intermittent reward.

- Psychological stress is about loss of control and predictability—a world in which reward and punishment become unpredictably intermittent.

- A study of people involved with the stock market showed that what predicted the secretion of stress hormones was when the market was gyrating. Increased variability—the more intermittent the rewards are—leads to higher stress hormone levels. The more gyrations, the more fluctuations, the bigger the stress response will be.

- At the same time, we love to give up control and predictability; that's what happens when we go into a scary movie. Generally, in

a malevolent setting, intermittency is about the stress response. In a benevolent setting, intermittency is about dopamine—that wildly addictive burst that you get as soon as the word "maybe" enters the scene.

- A 50% chance of reward maximizes the anticipatory goal-directed amount of dopamine. What some social engineers in Las Vegas are good at is being able to take humans and, in a circumstance where you have 0.00001% chance of getting a reward, make them think that they have a 50% chance.

- Hints of reward—such as someone telling you that you are lucky—are much more addictive and powerful when something that's highly unlikely is portrayed as being highly likely. On a fulcrum of "maybe," you work like crazy to receive the reward.

Dopamine and Our World

- We humans are reinforced by some very odd things—not just by eating when hungry or other basic instincts. We are reinforced by things that we have invented with culture.

- We live in a world in which getting some material item is capable of tapping into the same neurochemical system that has been working in our mammalian ancestors for ages.

- The keys to our dopaminergic system are the incredible speed with which the system can habituate and the incredible power the dopamine has to generate behavior—to generate goal-directed work when "maybe" is introduced.

- Our capacity to postpone reward begins to explain some of the greatest triumphs of human accomplishments, the human realm of phenomenal motivation and of reaching increasingly higher for your achievements.

- It also begins to explain some of our most crippled realms of human behavior, including addiction, dissatisfaction, and the

neurochemistry of constantly needing something new—this whole neurochemical world where something that was wonderful yesterday is exactly what you receive today but won't be satisfying tomorrow.

Important Term

Parkinson's disease: A neurological disorder that causes a person to lose all of the dopamine-releasing neurons in the part of the brain having to do with smooth movement.

Suggested Reading

Kipper and Whitney, *The Addiction Solution*.

Schultz, "Dopamine Signals for Reward Value and Risk."

Questions to Consider

1. What is the neurobiology of reward versus that of the anticipation of reward?

2. What is the neurobiology of a reward that is certain versus a reward that only has a chance of occurring?

How the Other Half Heals

Lecture 8

There are a few diseases that show an inverse gradient in terms of socioeconomic status—diseases that are more prevalent among the wealthy. Some of these cases have plausible explanations, such as breast cancer or melanoma. A few turn out to have been statistical flukes, such as polio. A few others are utterly mysterious, such as multiple sclerosis and rheumatoid arthritis. However, in at least one historical case, the health of the children of the wealthy suffered because their parents could afford a brand new medical procedure, which turned out to be a disaster.

The Socioeconomic Gradient

- The **socioeconomic gradient** is the fact that for diseases in Westernized countries, the lower you are in the socioeconomic hierarchy, the higher the incidence of various diseases and the greater mortality rate.

- This is seen with cardiovascular disease, pulmonary disorders, rheumatoid arthritis, gastrointestinal disorders, and psychiatric diseases. People have come to recognize that the stressfulness of lower socioeconomic status has an effect on health.

- In the last decade, work by Nancy Adler, showed that even more than objective socioeconomic status, subjective socioeconomic status is a good predictor of health. In other words, it's not just being poor, it's also feeling poor.

- Work by Richard Wilkinson analyzes communities and socioeconomic stress in terms of income inequity. In a community where for the same average income there are greater extremes of health on average, the effect of stress is worse. It's not being poor, it's feeling poor, and the surest way of feeling poor is having people surround you who are wealthier than you.

- This relationship between socioeconomic status and health is remarkably permeating; it can be used to predict health outcomes from very early in life and lasts for a long time afterward. These are very persistent effects.

The Inverse Socioeconomic Gradient

- There are rare cases where there is an inverse socioeconomic gradient in which the wealthier you are, the higher the incidence of disease. In some cases, it is mysterious that these diseases target people with higher socioeconomic status.

- For example, there are autoimmune diseases, where the immune system attacks what it thinks is an invasive pathogen but is actually part of your body, that are more common for people of higher socioeconomic status. Multiple sclerosis (MS) shows this inverse gradient.

- Sometimes, these inverse socioeconomic gradients reflect society's values and notions of beauty. In the beginning of the 20th century, economist Thorstein Veblen came up with his theory of the leisure class. One of the things he noted is that the wealthy work very hard to have conspicuous signs of their wealth. One of the ways to do that is to give off all the indicators that you don't have to soil your wealthy status with any sort of work.

- Veblen was the one who pointed out that wealthy ranchers in the 1880s would let everyone know how wealthy they were by taking a piece of their grazing land near the house and not allowing animals to graze on it. That way, it appeared to visitors that they did not need to make use of all of their land. This was the invention of the lawn.

- For centuries, one of the ways of communicating to the world your wealth was to make sure your skin was pale white, implying that you never had to stand out in the sun and be pummeled by the reality of the world. However, things have changed over the years.

- In the United States today, the wealthy try to have a year-round tan because of your beach house, your skiing lessons, and your golf lessons—signs of privileges. The inverse socioeconomic relationship is the wealthier you are, the higher the incidence of melanoma, the most dangerous form of skin cancer.

- Sometimes, what these inverse socioeconomic relationships reflect is not a higher incidence of the disease, but what is called a detection bias, where your socioeconomic status influences the likelihood of being diagnosed with a disease.

- An example is chronic fatigue syndrome, a highly mysterious disease. The wealthier you are, the more likely you are to be diagnosed with chronic fatigue syndrome. In one world, the symptoms lead to a diagnosis; in another world, you lose your job because you continuously show up late to work. In other words, it's not a real difference; it's just a bias.

- Sometimes, the socioeconomic gradient reflects socioeconomic differences in life-history trajectory. In Westernized societies, on average, the higher the socioeconomic status of a woman, the later she has her first child. She spends more of her life having menstrual cycles, exposed to high estrogen levels, and a seeming inverse relationship develops: The higher the social status, the higher the incidence of estrogen-sensitive breast cancer.

- Another case where there is seemingly an inverse socioeconomic relationship is polio. The standard picture of polio in the United States was that it was a disease of the wealthy. However, that turned out not to be the case: People of lower socioeconomic status were not less likely to get polio, they were just less likely to get diagnosed with it.

Hospitalism and Inverse Socioeconomic Status

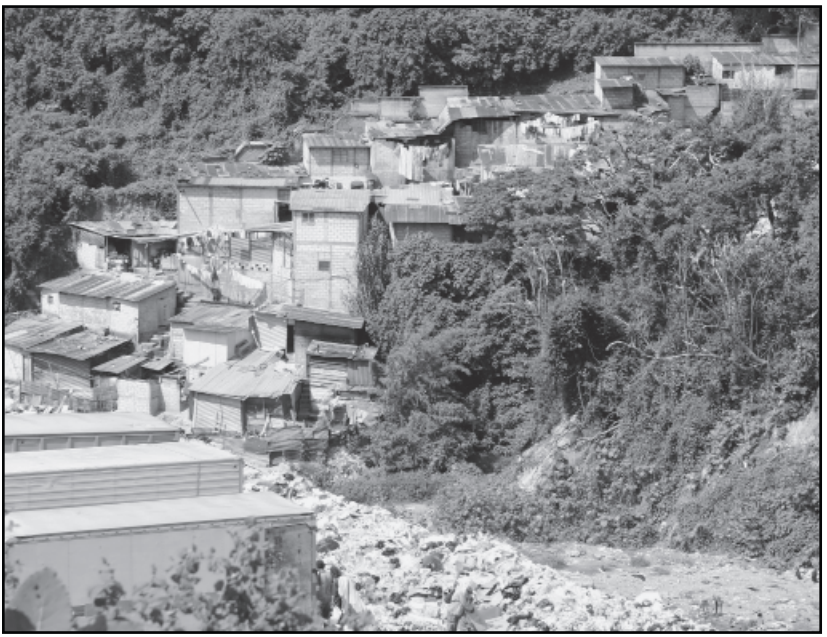
- Sometimes, there are true diseases of inverse socioeconomic status, and there is one in particular that teaches us about both the nature of health in the body and about the values of society. A disease called

hospitalism, which is an archaic term now, was a very relevant disease in the 20th century.

- The world of the early 20th century was a world of orphanages filled with abandoned children who had terrible survival rates. Hospitalism was a particular disease related to orphans that would come up with children who were already sick and in hospitals.

- Prior to the 1920s, you did not go to the hospital to get better; instead, you went to the hospital to be separated from the healthy people. Going to the hospital decreased your life expectancy.

- On average, if children were in hospitals for more than 2 weeks at a time, they would begin to show signs of hospitalism. After 2 weeks, a child would begin to have low energy and would lose



Scientists have discovered that a key predictor of health is socioeconomic status; the poor are generally less healthy than the wealthy.

body weight faster than could be explained by food intake. They would also have nonspecific gastrointestinal-tract infections and nonspecific pulmonary problems.

- Once children passed that 2-week mark, hospitalism led to a 10-fold increase in mortality rate. Most strikingly, this was recognized as an inverse socioeconomic disease from the beginning. When a child would go to the hospital, the higher the socioeconomic background of the child, the higher the likelihood of coming down with hospitalism and dying from it.

- People didn't understand this relationship then; it represents the intersection of 2 critical things about that period: Medical care was most fundamentally about hygiene—making sure people were not exposed to pathogens—and there was a view that children didn't really need much tender loving care.

- Around the year 1900, Luther Holt wrote the definitive textbook for childrearing at the time and described that parenting involved making sure children are adequately fed and kept warm enough. In his book, he refers to the vicious practice of holding children for too long because they are not meant to be pampered in that way.

- The view in hospitals was that a child should be fed and kept warm, but the last thing it needs is parental care, social contact, and physical touching. They believed that social connection and care had nothing to do with health.

- In the 1940s, a physician at New York University named Harry Bakwin was the first person to note that children in long-term hospital wards who succumbed to hospitalism were suffering from social deprivation, emotional deprivation, and loneliness.

- By the 1950s, a pioneering scientist named Harry Harlow suggested that normal development requires the avoidance of loneliness, such as social connectedness and love. The evidence began to emerge at that time.

- Classic work by Harlow with young, developing monkeys showed that if they had a choice between being attached to an artificial mother that gave it food and one that gave it comfort, they would become attached to the surrogate mother that gave warmth and contact.

- In the 1970s, research done by a psychologist named Tiffany Field focused on a population of human infants who were incredibly isolated from normal socialization and contact: extreme premature children in neonatal intensive care units (NICUs), which are extremely hygienic centers. She discovered that these children were never touched or handled. When there was an increase in the amount of physical contact, her research showed that these children grew faster and had fewer health complications.

The Morals of the Story

- With hospitalism, a vicious cycle developed. It began with a child being in the hospital for some kind of surgery who would begin to show signs of hospitalism. The logical response was that the child had been infected by a pathogen and that the environment was not hygienic enough. This led to isolation and, therefore, being cut off from practices that encourage normal mammalian development, which would worsen the hospitalism—which would cause even more hygienic hysteria.

- However, this cycle still doesn't explain the inverse socioeconomic relationship that mortality rate for hospitalism was higher in wealthy hospitals.

- Around 1900, there was a revolution in medicine that owed its existence to poultry science: egg incubators. It wasn't long before it occurred to someone to have infants who were sick, premature babies, in incubators as well.

- Only the wealthier hospitals could afford these newfangled incubators. As a result, children in wealthier hospitals were put in the apogee of isolation from all the things a developing child

needs, and that's why the rates of hospitalism were higher in wealthier hospitals.

- What this story teaches us is that good health is not just about germs. It also teaches us that normal child development is not just about adequate food and warmth.

- The most subtle and interesting moral is to be careful what you wish for. With medicine, if you are sick, you want to get the best access to the newest treatments available, but this type of thinking is dangerous if you are unsure of the consequences. Early in the last century, wealthy parents whose children were hospitalized were told that the hospital had the best and newest equipment.

Important Terms

hospitalism: An archaic term now, this disease of the early 20th century involved the deleterious effects on children who were already sick and in hospitals and who did not receive enough social care or physical contact to improve their health.

socioeconomic gradient: The tendency in Westernized countries that the lower you are in the socioeconomic hierarchy, the higher the incidence of various diseases and the greater mortality rate.

Suggested Reading

Bakwin, "Psychological Aspects of Pediatrics."

Marmot, *Status Syndrome*.

Sapolsky, "Sick of Poverty."

Questions to Consider

1. What are some diseases that show an inverse socioeconomic gradient?

2. What does hospitalism teach about infant development?

Why We Want the Bodies Back

Lecture 9

This lecture is about the strange need that we have in so many different cultures to be shown the bodies and to retrieve the bodies of the dead. Why is it so important to get the bodies back? It turns out that there are many reasons—not just for the good of the dead, but also for the good of the living. We want them back to be assured that the person is actually dead, to find out how they died, or to be assured that our cultural values are affirmed in dealing with the dead body.

The Dead and the Living

- There are many reasons we want the bodies of the dead. Sometimes, it is utterly, tragically, painfully obvious that an individual is dead, but we still want the body back for some affirmation of the event.

- In the aftermath of the terrorist attack on the United States on September 11, 2001, many people partook in the sacred task of trying to find the bodies of the victims.

- In 2001, after a Russian submarine sank, deep-sea divers risked their lives in incredibly dangerous operations to try to bring back the bodies.

- In Chile, decades after the murderous regime of Augusto Pinochet, elderly mothers of all the young protesters who had disappeared still gather, wanting even a single bone of their children so they know what happened.

- In 1587, Japan invaded Korea and defeated the Koreans. As some bizarre display of having defeated them, Japanese forces cut off the noses of the 20,000 dead Korean soldiers and brought them back triumphantly to Japan. A few years ago, Japan ceremoniously returned the noses to Korea.

- The trend we see in various cultures and in various centuries is the living being willing to risk their lives to retrieve the dead. However, it's not universal among humans to revere the dead, to have funerary rituals for the dead, to bury the dead, or to ritualistically cremate the dead.

- Until the 19th century in Europe, our modern notion of a cemetery didn't exist. People leased cemetery plots, and after a certain number of decades, the landlord dug up the bodies and leased the plots to someone else.

- In Westernized funerals, people speak in whispered reverence for the dead. The Nyakyusa people of Malawi ritualistically mock the person who has died. Why is it that in culture after culture we have this need to get the bodies back, despite the fact that there are different attitudes toward the dead?

- In traditional Haitian society, if you isolate yourself from everyone in your village, the people of the village will get a shaman to zombify you, which involves a neurochemical derived from puffer fish that causes you to be physically alive, but dead to your community.

- In traditional Singaporean Chinese cultures, there's a ritual in which the dead can be considered alive. If an older sibling dies unmarried, because younger siblings can't marry until the older sibling is married, they have to arrange a ghost wedding for the dead sibling involving an appropriate spouse, who is also dead.

The Bodies of the Dead

- Sometimes, the reason people will go to such extremes to get the body back is to be assured that there really is a body and that there really was a death. This reflects the fact that, historically, people had trouble telling when someone was dead.

- Before the stethoscope was invented, it was very difficult to be certain that a person was dead—as opposed to being in a coma.

This was accommodated in a ritual called a wake, during which mourners would sit with the body and check to make sure the person really was dead over a number of days, just in case the person woke up.

- In addition, there were fancy, expensive coffins that came with little bells inside so that, in case someone was pronounced dead who really wasn't, they could wake up inside the coffin and ring the bell. This actually happened every so often.

- Sometimes, getting the body back also helps you to overcome the denial of death, which is just a feature of our Westernized modern approach to death. The need to be an eyewitness and actually see the body is part of us bracing and dealing with the reality of death.

- Sometimes, this need to see the body is built around having to confirm that the person really is dead. However, there are other times when there is a need to know how the person died. This knowledge could be a realm of great solace or a realm of great pain.

In the aftermath of 9/11, volunteers engaged in the task of trying to find the bodies of victims for a long time.

- This is a world in which we get comfort from knowing that a person died in one way and not in another. For example, we take great comfort in the evidence that, on September 11, 2001, the people on United Airlines flight 93 apparently went down fighting.

- In many cultures—from the Tlingit people of Alaska to Orthodox Jews in Israel—there's a belief that you want the body back for the well-being of the dead, a notion that the proper transition into the afterlife requires the body being back.

- Sometimes, people want the body back—not for the well-being of the deceased—but for the well-being of the living. A funeral is very often a setting for conspicuous grief and conspicuous consumption, especially for the mighty and notable to display piety.

- The body of Lenin was mummified and was on display in Moscow at the Kremlin as if he were some Slavic saint. He was an atheist, and Soviet society was atheistic. The point that was being made clear to the peasants was that, through this display, they had crushed and replaced the system of belief that produces Slavic saints, and simultaneously, they had crushed and replaced the power of the Church.

- The strange world of body-part relics of the saintly, a theme that has run through Catholicism for centuries, is another realm in which the symbols of funerals and the symbols of death benefit the living. This act concerns people who might not have been powerful, but they were at least notable.

- In the 13th century, Elizabeth of Hungary was, by everyone's estimation, headed toward sainthood. Upon her death, a crowd promptly descended on her corpse and ripped it to pieces, dismembering it so that everyone could have a piece of the saint and display it forever.

- In the 11th century, a man who eventually became known as Saint Romuald of Ravenna, was someone who was so saintly that everyone knew he was going to become a saint sometime after

his death. He made the mistake of letting it be known that he was thinking of moving in with his children in the next town over, so the people of his town were going to lose their chance to get his body-part relics after his death. As a result, the town elders promptly conspired to kill him before he moved.

- The use of a body for the well-being of the living is quite frequent, and it's not just about people who are powerful or notable. This is what everyday funerals are about in the West; it is the setting to reaffirm the values of survivors.

- A funeral is a setting where we eulogize, very selectively, the memories of an individual—where we exaggerate some things and gloss over others. At funerals, we are typically proclaiming some of the values of our Westernized society, including having a robust work ethic, taking care of parents, taking care of children, and having a good sense of humor, of God, and of country.

Death and Culture

- Funerals are ways to not just show respect or reaffirm values within a culture, but they are also ways of showing respect for the values of a different culture.

- In 2001, a U.S. Navy ship accidentally struck and sunk a small Japanese fishing ship. In the aftermath, the United States took full responsibility for the accident and sent deep-sea divers on a rescue operation to bring up the bodies of the Japanese fishermen who were killed. They put enormous efforts into bringing up the bodies and treating them in a ritualistically correct way for traditional Japanese society.

- A similar theme involves wanting the body back to keep another culture from showing disrespect to your own. A traumatic example of that occurred in Iraq during the height of the U.S. war when there were some American consultants whose bodies were hung and burned. These had indelible impressions on the American

consciousness because people do not want the bodies of their culture treated that way.

- Joseph Mobutu, who was the kleptocratic dictator of Zaire for many years, was finally toppled, and in the last gasp of his dictatorship, he went back to his place of birth and had the remains of his family members dug up so that they could be taken away and not desecrated.

- Another bizarre example of this occurred when the United States benevolently gave up the canal zone to Panama. As the Americans moved out of the canal zone to return to the United States, they disinterred Americans in the cemetery to take them back home—just in case potential hostilities would someday increase the chance that American corpses would be desecrated there.

- An array of lawsuits have occurred between Native American groups and physical anthropologists over the propensity of physical anthropologists wanting to study the bones of the deceased individuals. In these cases, many Native American groups have spoken up, saying that the bones of their ancestors are not supposed to end up in museum showcases or be studied by graduate students. They're supposed to be buried and given sacred ceremonies. In many circumstances, cultural conflicts have arisen around the extreme reverence for the body.

Suggested Reading

Barley, *Grave Matters*.

Bondeson, *Buried Alive*.

Questions to Consider

1. What are some cross-cultural differences in attitudes and rituals about death?

2. What are some of the propagandistic uses of death?

Anatomy of a Bad Mood

Lecture 10

We've all experienced this: You get into an argument with a loved one that is eventually resolved, and just when everything seems to be heading back to normal, your loved one ruins everything by suddenly bringing up some tension from 10 years earlier—one you barely remember—and then you're engaged in an entirely different argument. There's actually a physiological explanation for this that deals with the fact that different parts of the brain recover from an agitating conflict at different speeds. Most intriguingly, there tend to be gender differences with how this works.

The Brain as Information Processor

- There is a standard contemporary model for how your brain figures out what emotions you're supposed to be feeling. When you see something that arouses a strong emotion, such as fear, the information is taken in by your eyes, which send it to your primary visual cortex and eventually to your associational visual cortex, which causes your limbic system—in particular, your amygdala—to have an excited realization. At this point, you're already feeling the emotions of terror, and eventually, your brain notifies the rest of your body through the limbic system.

- Your brain does this by way of the nervous system. The autonomic, or automatic, nervous system projects the information down from your brain and sends it throughout your body—to your fingertips, your hair cells, and your heart—telling your body what emotional state your brain is in and, thus, what body state should be occurring to match it.

- The autonomic nervous system comes in 2 halves: the sympathetic nervous system, which is responsible for emergency and arousal functions, and the parasympathetic nervous system, which is responsible for calm and vegetative functions.

- An elaboration of this current model came recently from a neuroscientist named Joseph LeDoux at New York University. The current model is that the brain figures out its emotional state by processing sensory information and then tells the rest of the body how to respond. LeDoux and his colleagues found a shortcut, a pathway by which the amygdala receives information before your cortex has consciously processed it.

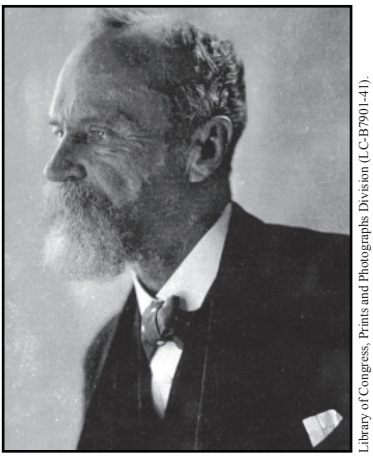
- The shortcut may allow you to have defensive responses before you're even consciously aware, but the shortcut also results in sending visual information before your cortex has done a careful analysis of it. This side path means your amygdala is getting emotionally laden sensory information very quickly, and it's not necessarily very accurate information.

- According to the famed philosopher and psychologist William James, both forms of this general model are incorrect. In fact, he suggested that the flow of information is exactly the opposite. Your brain doesn't figure out its emotional state and tell your body how to respond; instead, your body first has its bodily response, and based on that, your brain figures out how it feels about it.

- The James-Lange theory of emotion describes this unconscious processing of sensory stimuli that receives a bodily response. Part of how you consciously decide what's going on in the world and how you feel about it is your conscious brain canvasses what's going on in your body. If you are trembling, for example, you should look around because there must be something that is causing that trembling. This notion is counterintuitive, but there is support for it.

- There is evidence that signals from your body may not be telling you exactly what attributions to make, but they may be biasing or changing the intensity of the emotions you feel. These signals may be making you more or less sensitive to certain keys in your environment that would validate your emotional conclusions.

- There's one domain of research that supports this that has to do with facial expressions and the fact that your brain decides how it feels about something by, in effect, canvassing your face. The **facial feedback hypothesis** states that you can decide how you feel based on the movement of your facial muscles.



Library of Congress, Prints and Photographs Division (LC-B7901-41).

The work of American psychologist and philosopher William James (1842–1910) explains why arguments with loved ones often spin out of control.

- In a therapeutic setting, if you take someone with severe depression and force them to go through a completely artificial exercise of pretending to smile, they will, on average, begin to feel better. Their brain may be telling them that life is awful, but their muscles keep doing this thing that is associated with smiling, so they decide that maybe they don't feel that bad.

- Further research has shown that people who have received Botox injections in their faces experience less muscular correlates of emotion, so they feel less emotion. One remarkable study used volunteers that either had Botox or did not have it, and researchers asked them to mimic anger. People with Botox not only rated themselves as feeling less extreme anger, but they also didn't feel the emotion as intensely, as shown by the fact that their amygdalas weren't as activated.

- Quadriplegics also don't receive sensory information, so they have a blunted perception of emotions as a result. There are some rare diseases in which the autonomic nervous system does not work right. People with one of these diseases can have the same emotional processing in their brains as someone who doesn't have

the disease, but there isn't as much of a bodily response—emotions are perceived as blunted.

A Study of Emotions

- In the early 1960s, psychologist Stanley Schachter explored the notion that some of the time what your brain is doing is not so much having emotion caused by what's going on in your body, but if you are having a strong bodily response, your brain looks at the world around you for emotionally relevant environmental cues that it can attribute your bodily state to.

- In his classic experiment, Schachter gathered volunteers and told them they were getting a new type of vitamin called Suproxin, which supposedly helps eyesight. However, people were not really getting this imaginary vitamin. What they were getting—without knowing it—was a slow-acting form of adrenaline, also known as epinephrine, which kicks the sympathetic nervous system into action.

- Schachter had 4 different groups. One group got a placebo. Another group got the adrenaline, and they were accurately informed what the side effects were; they were told that Suproxin may make your heart rate and your breathing rate increase. The third group got the adrenaline, but they were not informed of any side effects. The fourth group got the adrenaline, but they were misinformed; they were told that they might get a headache or become itchy. In other words, they were not given a way to attribute their bodily responses.

- In the 3 groups getting the adrenaline, one group knew that Suproxin was supposed to make their hearts race, and the second and third groups had no idea. All of the groups were then released into the waiting room in the psychologist's office, where they were presumably waiting to have their eyesight tested. The actual experiment, of course, was occurring in the waiting room.

- Confederates of Schachter were planted in the waiting room, and they would either be a completely angry and impossible

patient, complaining about the wait, or a highly extraverted and positive patient.

- With the people who were given the adrenaline and were given the correct side effects, their hearts were racing, but they knew it was due to the Suproxin, so nothing happened to them. In the 2 groups that received the adrenaline but were either misinformed or uninformed of the side effects, their hearts were racing, but they had no way to attribute this effect to this fake vitamin, so they attributed it to the social environment instead.

- Furthermore, when the angry confederate was prompting the people in these 2 groups, they also got up and started yelling at the receptionist. With the highly extroverted and affable confederate, the people in these 2 groups began friendly conversations with one another.

- In other words, if you know why your heart is racing, you don't have to search for an attribution in the world around you. On the other hand, if you're experiencing a strong bodily state and don't know why that may be occurring, you will search around for explanations.

- Frequently, this same picture develops with the effects of other hormones. Oxytocin doesn't cause trust, but it lowers the threshold for you so that you can decide that there are cues in the environment to elicit this effect.

Emotions and the Real World

- If you've been a jerk and your beloved is furious, after you apologize, it should be all over. Just when it's about to be over, your beloved dredges up something awful that you did a long time ago. The critical reason why this happens is that your brain works at a different speed than your autonomic nervous system does.

- In the brain, the cortex and the limbic system switch back and forth incredibly quickly. The problem is that the autonomic nervous system is like a locomotive. Once the emotion is over, your

autonomic nervous system takes much longer than the brain to get back to normal. Therefore, your cortex and limbic system might know that the fight is over, but the rest of your body is still roaring along, slowly returning from the storm created by the sympathetic nervous system.

- When the fight should be over, your heart is still racing and you still feel angry, so your brain searches for an attribution, so it resorts to the awful thing the person did in the past.

- A final disturbing piece of this scenario is that there appears to be a gender difference. On average, men turn on the sympathetic nervous system more rapidly than women do, and on average, women keep it turned on for longer than men do, resulting in a longer recovery time after the end of a fight.

- The next time you have one of those fights, get everyone to take a deep breath and have everyone sit down after it's over, in order to help turn off the sympathetic nervous system.

Important Terms

facial feedback hypothesis: The hypothesis that people can decide how they feel based on the movement of their facial muscles.

Suggested Reading

Damasio, *The Feeling of What Happens*.

Tannen, *You Just Don't Understand*.

Questions to Consider

1. How do events in the body influence emotion?

2. What is an implication of the autonomic nervous system turning on and off more slowly than the brain?

This Is Your Brain on Metaphors

Lecture 11

If a person thinks about a despicable thing they did that they feel awful about, their insular cortex, which is involved in processing gustatory disgust, is activated. Furthermore, we feel sick to our stomachs to think about some act of moral depravity. When humans evoke complex metaphorical states of mind—feeling someone else's pain or thinking that someone has a warm personality—some very concrete parts of the brain handle the job. This helps to explain the extraordinary power of symbols and metaphors.

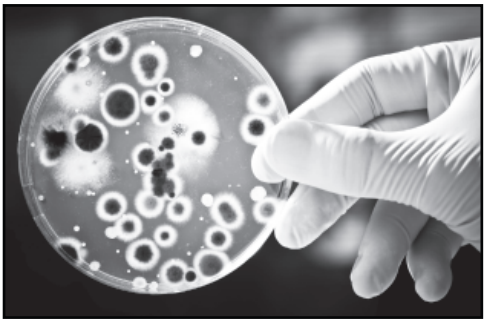
The Power of Metaphors

- The human brain gains enormous power out of the very simple but fascinating neurobiological fact that it processes metaphors and symbols in very literal, concrete ways and sometimes falls for the literality of these devices. Furthermore, the physicality of some metaphors—and our ability to confuse them with reality—can change our opinions and assessments.

- Scientists Mark Landau, Daniel Sullivan, and Jeff Greenberg had volunteers read a passage about U.S. history that was written in a personified way—as if the United States was a real organ that "matured." Before reading that passage, people either read a short piece about the dangers of invasive pathogens, or they read a neutral passage (the control group). People who first read about invasive pathogens were more likely to have a negative view about immigration.

- In an experiment conducted by John Bargh and his colleagues at Yale, volunteers were supposedly evaluating a candidate for a job. These volunteers were either holding a heavy clipboard or a light one, which contained materials about the candidate. People who held a heavy clipboard were more likely to perceive the candidate as being serious and having more gravity to them. In other words, this

physical heaviness translated into a metaphorical version of a weighty situation.



People in a study were more likely to have negative views about immigration when reading an article on U.S. history after reading about the menace of bacteria.

- In another version of this study, people were again assessing imaginary job candidates, but the volunteers doing the assessment were now sitting in either a large, comfortable chair or small, hard chair made of wood. People who sat in the hard, upright chair were more likely to assess the candidate as having an inflexible personality, as being more rigid, which is what they were feeling subliminally about their seating situation.

- In another study by Bargh and colleagues, volunteers enter an elevator on their way to the study and are met with someone else getting into the elevator—a confederate—who is holding a large pile of books and is struggling to hold onto their cup of coffee. The confederate asks the subject to help them by holding their coffee. In one case, it's a cup of hot coffee, and in another case, it's a cup of iced coffee. As a result, the subject's hand is either warm or cold from the coffee. Shortly afterward, in the study, when the subject is asked to assess some hypothetical personality, if he or she had been holding the cup of warm coffee, he or she was more likely to assess that person as having a warm personality.

- Most remarkably, the brain's confusion comes through in another study that shows not only can it change your opinions and assessments, but even your action. In a 2-part study carried out by Chen-Bo Zhong and Katie Liljenquist, volunteers were asked either to recall some circumstance in their past in which they had a

dreadful moral failing or to recount some unemotional circumstance (the control group).

- Then, the volunteer was offered a small gift from the researcher for completing the study: a gift pencil or a little package of antiseptic wipes. If the volunteer had just spent time wallowing in moral degradations, he or she was more likely to pick the antiseptic wipes than if he or she had recounted some neutral event. The reasoning is that these volunteers felt soiled and needed to wash their hands of their past.

- The second part of this experiment was even more interesting. All of the volunteers were asked to wallow in their moral failings, and afterward, they either finished the study and left or were given the opportunity to wash their hands. After returning to the room, a confederate of the experiment happens to pass through and drop some papers. People who got to wash their hands were less likely to get up and help because they were less driven by their moral failings in the past that might motivate them to help another person.

Metaphors and the Brain

- There is an intermixing between metaphor and the literal in which the brain confuses bodily states with moral ones. Remarkably, people are beginning to understand what's going on in the brain when this occurs: The brain has trouble distinguishing between physical and metaphorical versions of things that happen to use some of the same concepts.

- A fascinating region of the brain is called the insular cortex. In most species, when you take a bite into something that turns out to be rotten, your insular cortex activates. This part of the brain is really good at detecting gustatory disgust or olfactory disgust.

- More subtly, instead of eating something disgusting, just think about grabbing a cockroach and biting its head off. In most humans, if you're really contemplating it, your insular cortex will be activated.

In other words, with humans, it's not only about sensory disgust, it's also about thinking about sensory disgust.

- In addition, just hearing stories about people who are engaging in extreme moral failures, making you feel sick to your stomach, activates your insular cortex. Sometimes, it becomes confused when distinguishing between sensory and moral disgust.

- In another study conducted by Bargh and his colleagues, volunteers played a formal economic game in which they constantly had to choose between being cooperative or being competitive with another person. Before playing the game, volunteers held in their hands either something warm or something cold. If they held something cold, they had more activation of the insular cortex and played in a colder, more selfish way.

- Another region of the brain that shows a similar problem that is located near the insular cortex is an area called the anterior cingulate cortex, which deals with pain perception. One part of the anterior cingulate cortex informs you about which parts of the body are in pain—the literal features of pain—while another part assesses the meaning of the pain so that you can react to it.

- When people watch a loved one get poked with a pin, the part of the brain that involves telling them which part of the body is hurt doesn't get activated, but the assessment portion does. Metaphorically, the anterior cingulate cortex can feel someone else's pain, or experience empathy. This shows that the brain has trouble distinguishing between the metaphorical version of feeling pain and the literal version.

- There's a neurotransmitter called substance P that helps mediate pain. There are drugs that will block substance-P signaling so that pain pathways don't work as well. Some of these drugs can have antidepressant effects. In other words, depression, the disease that on a certain metaphorical level involves feeling the pains of the world, is in some literal way tapping into some of the pain

neurobiology of a real painful stimulus. There is something very similar—and not just metaphorically similar—between somatic pain and psychic pain.

- In order to handle metaphor, when we humans transitioned from being a species that could merely handle sensory disgust to handling moral disgust, the insular expanded its portfolio to include both the literal and metaphorical versions of things, and that's why it has trouble distinguishing the 2 at times.

The Power of Metaphors in Politics

- Consider one of the most catastrophic events in history in recent decades: the genocide in Rwanda in the 1990s that involved the Hutu ethnic group turning on the Tutsi ethnic group in a bloodbath. Over the course of approximately 6 months, 70%–80% of the Tutsi group were slaughtered. This was an outburst of longstanding interethnic animosities.

- This genocide had been being planned by Hutu leadership for a long time beforehand. Part of what was going on was a propagandistic machine; Hutu radio stations railed against the Tutsis by referring to the Tutsis as cockroaches that the nation needed to be cleansed of.

- This was intentionally very neurobiologically insightful. The leadership propagandized the Hutu group to the point that if they said the name of the Tutsi group, the insular cortices of the Hutus were activated and they were ready to leap into the bloodbath.

- When Nelson Mandela came out of his imprisonment, he was going to have to negotiate the transition to the new free South Africa with a group of hardliner Afrikaans. One of the remarkable things he had done while in prison was make a point of learning Afrikaans from his jailers so that he eventually became fluent in it. At the start of these negotiations, he would greet these hardliners in the most informal and warm Afrikaans. This familiarity undid the resistance,

showing the power of reaching out and expressing a symbol of respect for them by speaking their language.

- Another realm in which this can be seen reflects the work of political scientist Robert Axelrod, who focused on the peacemaking process. He studied how peace may come in some circumstances built around figuring out economic differences, but where peace truly will come is when you give signals that you are respecting the cultural symbols of another group.

- Axelrod conducted some remarkable studies in which he interviewed hardliners in the Palestinian/Israeli conflict. As discovered in the responses he received from both parties—which noted that each group only desired respect from the other group for its culture—there is a tremendous capacity for, perhaps, recovery and healing in this situation, where the peace between Israel and Jordan has been on hold for decades.

Suggested Reading

Geary, *I is an Other*.

Lakoff and Johnson, *Metaphors We Live By*.

Rozin, Haidt, and Fincher, "From Oral to Moral."

Questions to Consider

1. What is the neurobiology of the fact that humans often confuse the literal with the symbolic?

2. What are some historical examples of the power of symbols?

Sushi and Middle Age

Lecture 12

If you're like most people, as adulthood crept in, you became less interested in new things and more set in your ways. In this final lecture, we will consider why we humans—as well as members of other species—tend to close our minds to novelty and come to love the familiar over time. The literature reveals the psychology, neurobiology, and evolution behind this phenomenon. Despite some surprising advantages to the closing of the mind, it should be resisted because an open mind is a prerequisite for an open heart.

Aging and Novelty

- How do we lose our capacity to be open to novelty? What happens with our openness to trying new music, food, or fashion as we get older? Early in life, we are open to tremendous novelty. Why, then, do our brains close to novelty as we get older?

- There seems to be a pattern that, in general, the creative output of the most creative people decreases over time, for example. This statement does not just refer to the world of mathematicians and physicists; it also applies to composers and poets. On average, the number of measures of music composed or the numbers of lines of poems written decreases with age.

- It is important to remember that this effect is not universal, and there are dramatic exceptions. For example, Henri Matisse was inventing new art styles in his 80s. On average, however, the most creative minds produce less as they age.

- In terms of making sense of this, even more important is the evidence that many of those gigantically creative minds are less open to other people's novelty as they get older.

The Neurobiology of Aging

- Neurobiologically, what's going on in the brain as we get older? Why do we lose openness to novelty? People used to think, incorrectly, that as we get older, our brains begin to rot.

- People used to think that they understood brain aging. It was very straightforward, and it went as follows: Until the age of about 21, your brain is great—your **synapses**, the connections between different neurons, are all excitable, and you are able to learn new things. Then, suddenly, something happens and you start losing brain cells. You start losing neurons. You begin to lose 10,000 neurons per day, every day, for the rest of your life. By the time you're 40, you have lost all of your neural complexity. This was thought to be normal, inevitable brain aging.

- In retrospect, we now understand why this concept was totally erroneous and why it was inadvertently accepted as dogma. It was due to a very influential but very wrong study that was conducted in the 1950s in which some neurobiologists, who were trying to understand what happens to the number of brain cells as we age, set out to try to count the number of neurons—knowing that nobody was ever going to try to conduct this experiment again.

- These neurobiologists studied the brains of people who were so aged that they couldn't even remember their name or who they were. In retrospect, this was their mistake. They were not using the brains of normally aging individuals; instead, they were using the brains of people with Alzheimer disease and other types of senile dementia.

- Through the analysis of their data, they discovered a catastrophic decrease in neuron number. They came up with the magical number that adult individuals lose 10,000 neurons per day, every day.

- In the years since this study, we have learned that this is not an accurate picture of the aging brain. People do lose some neurons in some interesting parts of the brain, specifically in the brain region

that's responsible for smooth movement. People also lose neurons in the hippocampus region, the region of the brain associated with memory. Very interestingly, people lose neurons in their frontal cortex and, therefore, lose some aspects of emotional regulation.

- For the most part, however, you're not losing massive amounts of neurons. In addition, your brain can actually improve over time. Those synapses, those connections between neurons, sometimes become more powerful and more excitable. Neurons can grow new connections that result in new processes. A major revolution in neurobiology is the fact that the adult brain, even the aged brain, can generate brand new neurons.

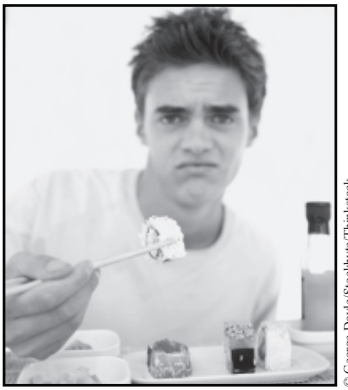
- Neurons can be born in the adult brain in response to all kinds of stimulating environments. Therefore, neurobiology doesn't explain the brain's predilection to closing to novelty. It is not the case that your brain is falling apart with time and that there is a novelty center in your brain that rots. Neurobiology doesn't tell us much about the process of aging.

The Psychology of Aging

- A psychologist named Dean Simonton first documented the decline in openness to novelty in highly creative individuals. He discovered that what seemed to be an age-related phenomenon was actually not a function of chronological age; instead, this effect was a function of disciplinary age. In other words, it was not about how old someone was, but it turned out to be about how long they had been in the same discipline. People who changed disciplines, jobs, or foci were able to reset the clock on openness to novelty.

- Part of the complication with this result concerns how much of this is self-selection. There's also the issue of whether people are truly having different behaviors or whether they are having the same behaviors in a different context. Nevertheless, it is clear that the process of making a major change has some very beneficial effects on the nervous system.

- In the early 1960s, some Berkeley scientists, and in particular a man named Mark Rosen, conducted landmark studies that involved baby rats. Their studies showed that raising young rodents in a normal environment in the lab versus in an enriched environment—a rat nursery with other baby rats, running wheels, and beeping lights—resulted in very different outcomes. In an enriched environment, the brain matures faster, and the cortex becomes larger. These rats have better learning abilities.



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Sushi is an example of a novel type of food that our brains often close our minds to as we age.

- A neurobiologist at Berkeley named Marian Diamond was a young scientist at that time. It occurred to her to conduct a study that analyzed whether environmental enrichment had some of the same beneficial effects on the adult brain. She found that environmental enrichment made for a more complex adult rodent brain with more synapses, stronger synaptic connections, and even more neurons in aged individuals.

- Brain maturation is a lifelong process. Diamond's findings provide a neurobiological explanation for why switching disciplines, jump-starting the whole system, can have some very rejuvenating effects on the brain.

- Furthermore, Dean Simonton, who studied highly creative individuals, noted that if you are entrenched or eminent in your field, what makes it so unlikely for you to have an open mind is the fact that anything new that comes into play might mean that you and your colleagues will get tossed out of the textbooks.

- There is some fascinating research being done that shows that the more eminent and aged a person is at the time a new revolution sweeps in, the less likely they are to embrace it.

- This reasoning, however, has limited explanatory power: The danger of being too eminent in your discipline and fearing novelty still does not explain why you are not open to listening to new music in old age. There's no reason to believe that listening to new music is going to increase the odds that classic musicians are going to be tossed out of the music textbooks.

- The work of Judith Rich Harris has emphasized the extraordinary power of peer influences and socialization, especially during development. Basically, she has shown that at around age 15, what you want to communicate to the world more than anything is that you have nothing in common with the older people who have come before you. You want some markers that you and your generation have done something individuating.

- As a result, your generation comes up with its own version of a cultural outrage that defines your generation and your peer identification. This process of age-group identification tells us a lot, but it still ends up being insufficient to explain our nature to be closed to novelty over time.

- For example, rats show the same pattern as humans over time. Baby rats are extremely phobic about new foods. Then, suddenly, in rat adolescence and into early adulthood, they're willing to try new things. As they get further into adulthood, their window of novelty closes. This pattern suggests that the biology of this pattern is hardwired.

Fighting the Closing Mind

- Instead of asking why, as we get older, we close to novelty, maybe the question should be why we like repetition more as we age. It seems that when the sand underneath your feet is getting turned into quicksand with less and less certainty, something familiar

and repetitive that can be predictably relied upon can take on an enormously reassuring power.

- There are a few reasons why you may want to fight the mind's predilection to closing to novelty. First, it should not just be the purview of the young to have new thoughts and feelings; everyone should be able to reap the benefits of the world's vibrancy and all the new things it comes up with.

- In addition, people who are open to the most important type of novelty see someone in need, who on first pass is very different from them—different appearance, different beliefs, different language—and at that juncture, where they could see either the differences or the similarities, they're open enough to see the similarities and mobilize to help.

Important Term

synapse: The point of connection between neurons.

Suggested Reading

Lindauer, *Aging, Creativity, and Art*.

Simonton, *Origins of Genius*.

Questions to Consider

1. What are some psychological insights regarding why we become less open to novelty as we age?

2. What are some zoological insights regarding why we become less open to novelty as we age?

Glossary

anxiety: The state of seeing stressors, menace, and threats that other people don't; in other words, turning on the stress response at times when other people are not perceiving anything.

ectoparasite: A type of parasite that remains outside the body of an organism and alters the behavior of its host.

endoparasite: A type of parasite that gets inside the body of an organism and alters the behavior of its host.

facial feedback hypothesis: The hypothesis that people can decide how they feel based on the movement of their facial muscles.

hospitalism: An archaic term now, this disease of the early 20th century involved the deleterious effects on children who were already sick and in hospitals and who did not receive enough social care or physical contact to improve their health.

metabolic syndrome: A syndrome that serves as the first hint of vulnerability for both diabetes and cardiovascular disease, among other diseases.

parasite: An organism that targets and invades other organisms for its own benefit.

Parkinson's disease: A neurological disorder that causes a person to lose all of the dopamine-releasing neurons in the part of the brain having to do with smooth movement.

phototropism: Having an attraction to light.

prosocial human: Individuals who look out for others and who are willing to do something altruistic, even spontaneously.

rapid eye movement sleep (REM): The stage of sleep associated with dreaming.

reductionism: The notion that to understand a complex system, you need to understand its component parts.

resurrectionist: In the 18th century, a person who would obtain bodies of the dead and sell them to anatomists at medical schools to learn about the human body.

slow-wave sleep: The deepest stage of sleep.

socioeconomic gradient: The tendency in Westernized countries that the lower you are in the socioeconomic hierarchy, the higher the incidence of various diseases and the greater mortality rate.

sudden infant death syndrome (SIDS): Known as crib death in the early 20th century, this is a disorder in which a perfectly healthy child, typically a baby, is put to sleep at night and mysteriously dies.

synapse: The point of connection between neurons.

toxic hostility: A modern incarnation of a type A personality in which people believe that everything that occurs in the world is proof that everyone is out to get them, and the only defense they have is to watch their backs at all times. The profile of someone who exhibits toxic hostility includes increased risk of cardiovascular disease and overactivation of the sympathetic nervous system, which controls adrenaline.

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